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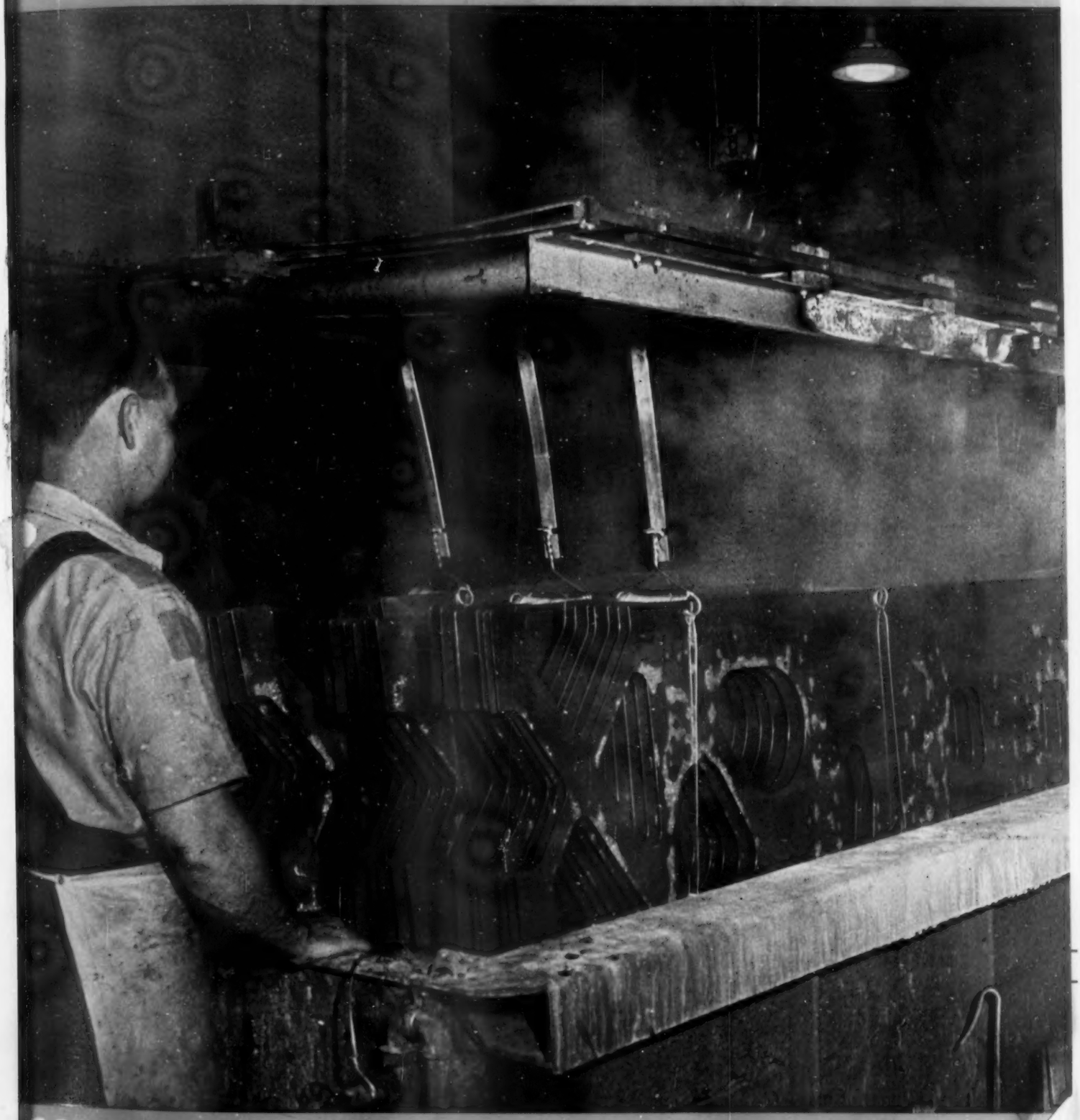

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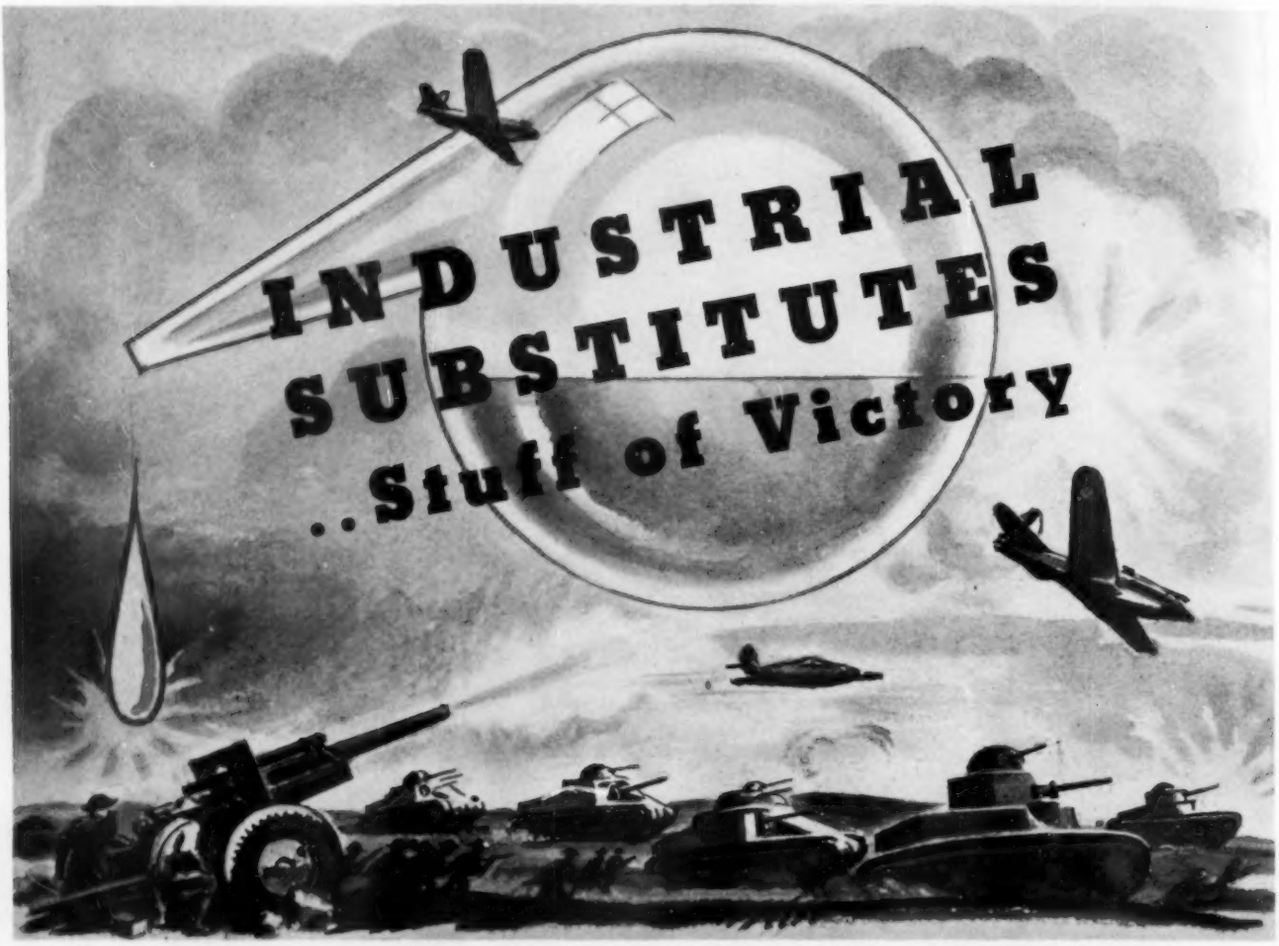

With the national war effort paramount, American industry today is proving that substitution does not mean cheap "Ersatz" . . . that a high degree of quality can be maintained . . . that out of the demands of necessity and the genius of the laboratory are coming new ways to overcome old problems.

To enable industry to supply the basic needs of the civilian population while putting the demands of our armed forces and those of our Allies in first place is largely a matter of releasing needed raw materials by the creative use of all available supplies.

Zapon Division is formulating finishes based on available materials that do the job—at the same time releasing critical materials which go off to war. Zapon cooperates with its customers in developing and using new finishes which will help satisfy the nation's needs while contributing directly and indirectly to the national war effort.

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INDUSTRIAL FINISHES

Section of

METAL FINISHING

Founded January, 1908
as Metal Industry

Publication Office
116 John Street, New York

ORGANIC FINISHING

SECTION OF METAL FINISHING

APRIL, 1942

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It is plain to everyone that, as more men are called into our armed forces and more of our country's manufacturing facilities are turned to war production, there is certain to be a lack of trained workers in almost every field. Many industries have already felt the pinch. Others will probably feel it very soon. In this respect the finishing industry is no exception.

What can be done in the finishing industry to secure trained finishers—sprayers, sanders, mixing room men, touch-up men, etc. when the need arises. There are several ways out. First, do nothing until the necessity for trained finishers becomes pressing and then call on the government for aid. Second, simply hire finishers by offering higher wages than anyone else. Both of these methods are selfish and unpatriotic and no thinking manufacturer would employ them. Certainly neither one of them tends to aid in keeping our war effort running smoothly and with no delay.

By far a better way, if somewhat more difficult than those mentioned above, is for each manufacturer to train his own finishers. We do not, of course, propose to give in the short space of this editorial details of how such a training course should be conducted. However, we do have one suggestion to make. Do not limit any training program to merely assigning apprentices to experienced finishers to be instructed during the regular working hours. If it is desired to produce trained finishers in a minimum of time, then extra instruction and practice are absolutely necessary. This simply means instruction periods after the working day is ended. We are not at peace and cannot afford to train men by the slow methods of peacetime. We are at war and war demands the utmost effort in order to get the most done in the shortest time. The more time spent in training men, the sooner these men will be producing goods to defeat our enemies.

L. H. LANGDON, *Publisher* • T. A. TRUMBOUR, *Business Manager* • DR. WALTER R. MEYER, *Editor*

Finishes for Aluminum Die Castings*

By A. E. KESKULLA[1] and JUNIUS D. EDWARDS[2]

ALUMINUM die castings are covered with a thin, transparent oxide film which constitutes one of their important advantages from a service standpoint. For numerous applications, the ability of aluminum alloys to form and maintain this natural film is sufficient protection, and further finishing is not necessary. For many other applications, however, where a more decorative appearance or better resistance to service conditions may be desirable, a wide assortment of durable and attractive finishes is available. These finishes are classifiable under the headings:

1. *Mechanical finishes*, developed by abrading or working the die-cast surface by mechanical means to obtain a polished or textured effect.
2. *Chemical finishes*, produced by treating the castings with chemical solutions to produce etched surfaces or oxide coatings having a wide variety of properties.
3. *Anodic finishes*, formed by anodically oxidizing the casting in a suitable electrolyte to form a substantial oxide coating. The oxide coating may then be given supplementary treatments to seal or color it.
4. *Electroplated finishes*, applied by the electrodeposition of metals such as nickel or chromium on the aluminum surface.
5. *Paint and organic finishes*, which comprise a multitude of clear and pigmented coatings applied by spraying, brushing, or dipping.

Just which of these methods will be used, or combined, in a commercial finishing procedure for any die casting will depend on such various factors as sales and service requirements, cost considerations, design of casting —size and shape, and alloy choice. Where no background of experience exists, it is advisable for the user of aluminum die castings to consult with the die caster or an experienced jobbing finisher in reaching a decision.

Mechanical Finishes

Mechanical finishing methods are used extensively in preparing die-cast surfaces for other types of finish as, for instance, in the roughing or oiling of castings to remove surface irregularities prior to paint or enamel application, or developing a buffed or textured surface for electroplating or anodic coating. Where mechanical finishes are used without subsequent treatment, they serve a decorative purpose, since they have no substantial effect on abrasion or corrosion resistance. They do not detract from the characteristic resistance of aluminum die castings to ordinary indoor exposures and, in general, they simplify the process of periodic cleaning or polishing.

Polishing

The sequence of operations generally referred to as polishing may begin with "*roughing*." This is accomplished with a wheel of glued rag construction, having a working surface of relatively coarse emery particles, 80 to 120 mesh, embedded in glue. Wheel diameters range from 6 to 16 in., thicknesses from 1½ to 3 in. Speeds of about 6,000 ft. per min. are suitable for most work. The use of a tallow or composition lubricant will avoid excessive heating and thus prevent breakdown of the glue binder.

"*Oiling*," sometimes referred to as greasing, is a refinement of the roughing procedure, using finer abrasives and softer wheels. For the average die casting, where flow marks and other surface roughness are not too deep, oiling may be the initial step in polishing. Here the wheels are of solid felt construction, faced with emery of 120 to 200 mesh. Wheel speeds, dimensions, and lubricants are approximately the same as for roughing. Selection of a felt of suitable hardness is important in obtaining the proper work pressure without affecting the contour of the surfaces. Small irregular surfaces require softer wheels than flat, extended sections.

In *buffing*, wheels are built up from a series of stitched rag buffs, hardness being controlled by the extent and manner of stitching. The abrasive and lubricant are usually in the form of a cake—such as tripoli powder in a grease binder—which is periodically applied to the wheel surface. Pastes containing the abrasive and lubricant are also used, and are applied to the work with a brush. Buffing wheel speeds range from 7,000 to 7,500 surface feet per minute. Satisfactory results depend upon a proper balance of buff hardness, abrasive compound, wheel speed and work pressure, developed through experience with individual jobs.

"*Coloring*" produces a surface of high gloss, either as a final finish, or as the foundation for other finishes. Before this operation, it is advisable to remove abrasive from previous steps by means of solvent cleaning, or, where particles have become embedded, by a light caustic etch. Open muslin or flannel wheels are used, to which soft silica or lime is applied as an abrasive. Wheel speeds should equal or slighty exceed those for buffing—7,500 to 8,000 ft. per min.

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*The presentation of this paper at the annual meeting was sponsored by Committee B-6 on Die Cast Metals and Alloys. Reprinted from "Proceedings of the American Society for Testing Materials" **41**, 931-940 (1941).

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Scratch Brushing

A textured effect of attractive appearance can be achieved by scratch brushing. This may be done on the as-cast surface, following a cleaning operation, or a light acid etch which serves to clean the casting and promote uniformity of finish. Wheels are made with stainless steel, brass or nickel silver wire, about 10 in. in diameter and with wire size from 0.010″ up, depending on the coarseness of texture sought. Wheel speed should be about 2,000 r.p.m. The removal of metallic particles by a soft brick, and periodic reversal of the direction of rotation are necessary to maintain the cutting action of the wires. An acid dip after scratch brushing is frequently employed to remove imbedded metal particles coming from the brush.

Satin Finishing

Scratch brushing practice may be modified, using smaller softer wheels (0.002″ to 0.005″ wire) to produce a satin finish. The results differ from the scratch brushed surface by having finer lines of less depth and may therefore require an initial oiling treatment to work out surface roughness.

Wheel speeds for satin finishing range from 450 to 600 r.p.m.

A similar effect is obtainable in the regular polishing routine by substituting for the buffing operation one involving the use of a greaseless satin finishing compound. In this case, the action of the abrasive is to produce fine parallel lines similar to those produced by fine wire brushing.

Ball Burnishing

Ball burnishing is well adapted to the low cost handling of parts in quantity, and is a popular method of finishing aluminum die castings. The castings are tumbled, in batch lots, in rotating wood lined barrels. As a result of the peening action of the steel balls, stars or other variously shaped members comprising the abrasive charge in the barrels, a bright finish is produced. Barrel speeds of 15 to 35 r.p.m. and burnishing times ranging from 30 to 60 min. are employed. Ordinarily, shapes and castings in the volume ratio of 2:1 fill the barrel about one half full. Clean water, to which is added a few ounces of neutral soap flakes, brings the level to about two thirds full. It is important that parts be cleaned before burnishing or given a light acid etch followed by a water rinse. To avoid stains, the barrel must be kept free of dirt, grease, heavy metals and their salts, and the solutions should be neutral or very slightly acid. Following burnishing, the castings should be rinsed in clean, hot water and dried in sawdust.

Sand Blasting

Sand blasting is a rapid method for giving a uniform matte finish to the surface. The texture and color of the sand-blasted surface are determined by the grade of sand or abrasive employed, the rate of introduction of the sand, the air pressure, and nozzle to work distance and angle. The conditions selected must be strictly adhered to if a uniform surface is to be obtained from casting to casting. The use of fine sand (dust blasting) is sometimes employed, particularly as surface preparation for castings which are to be anodically coated. Parts which are to be anodically coated may also require a short treatment with hot caustic soda solution after blasting, in order to remove embedded abrasive. This etching treatment also results in a lighter color in the finished oxide coating.

Interesting two-tone effects can be secured by combinations of polishing, buffing and sand blasting.

Chemical Finishes

Caustic Etch

Aluminum die castings can be given a frosted, etched surface by treatment in a hot caustic soda solution. The solution should contain about 15 per cent sodium hydroxide and be used at a temperature of 160 to 180° F. The time of etching will depend upon the effect desired and the concentration and temperature of the solution. After etching, the casting is rinsed in clear, cold water and then given a neutralizing and brightening treatment by immersion in a strong mixture of nitric and hydrofluoric acids. This is composed of eight parts of concentrated nitric acid and one part of concentrated hydrofluoric acid; it should be handled with great care. The presence of the hydrofluoric acid is essential if the alloy contains silicon in substantial amounts. After this treatment, the article is again rinsed in clear, cold water and dried on a steam table. The hydrofluoric-nitric acid mixture should be used cold; if it becomes too warm during use it produces a yellow film which is difficult to remove. The acid mixture can be held in a tank lined with carbon brick. Lead is also used, but cannot be considered as permanent.

Alrok Coatings

Aluminum die castings can be oxide coated by simple chemical treatments, known as Alrok[3] processes. One of these, which is commonly employed, comprises treatment of the die casting in a hot solution of sodium carbonate and dichromate of a predetermined ratio. A substantial oxide coating forms after an immersion period of about 15 min.

This oxide coating gives increased abrasion resistance to the surface, but is much less effective in this respect than a good anodic coating. The protection it gives in corrosive environments can be further amplified by sealing in a hot dichromate solution. In cases where die castings are to be subjected to severe service conditions, it is frequently found desirable to apply such a chromate sealed oxide coating preliminary to painting or enameling the casting.

Anodic Oxide Coatings

Anodic oxidation methods provide means for giving aluminum die castings an oxide coating of substantial thickness and abrasion resistance. Some of these oxide coatings may be used for their decorative effect without further treatment, or they may be given a wide range of colors by impregnation with dyes or mineral pigments. Furthermore, some anodic coatings offer important protection against corrosive environments. As commercially applied, these coatings are usually in the range of 0.0001″ to 0.0005″ in thickness.

The method of application is simple and can be closely controlled. The article to be coated is given the necessary preliminary treatment to clean the surface and give it the desired polish or texture; it is then made anode in a suitable electrolyte. The most commonly used electrolytes are solutions of chromic acid and sulfuric

3. Alrok is a registered trademark of Aluminum Company of America.

acid in various concentrations. The coatings produced in chromic acid electrolyte are generally thin, of a gray-green color, and cannot be satisfactorily applied to castings containing more than about 5 per cent copper. They are frequently used as surface preparation for painting.

Dilute sulfuric acid is employed in the Alumilite process[4] and the time required for coating ranges from about 10 min. to 1 hr. On pure aluminum, the oxide coating thus formed is transparent or substantially colorless, but the color and appearance may be profoundly modified by the alloying elements always present in die castings.

These effects may become apparent in the hardness, porosity and protective value of the oxide coating as well as in color and appearance. Depending on their electrolytic behavior, alloying constituents may be anodically dissolved during the coating operation, may be oxidized and remain in the coating, or may remain in the coating in the unoxidized state. Silicon, for example, is a constituent which is not appreciably dissolved or oxidized during the Alumilite treatment and remains in the coating, and affects its color and appearance. Die castings with a substantial silicon content are usually gray to black in appearance after being anodically oxidized. Iron constituent also tends to discolor the oxide coating and should be kept at a minimum where light-colored, uniform coatings are desired. Copper constituents, such as $CuAl_2$, also important in die castings, have quite the opposite behavior; these constituents are anodically oxidized and dissolved at a more rapid rate than the aluminum matrix. As a result, the coatings formed on an alloy containing substantial amounts of copper tend to be quite porous and have lower abrasion resistance and protective power because of the anodic solution of the copper constituent. Magnesium forms a white or colorless oxide, but alloys containing substantial amounts of undissolved magnesium constituent have a dark appearance when anodically coated. Alloying elements in solid solution have the least effect upon the color of the casting after oxide coating. Heat treatment of the die casting will affect the amount and degree of dispersion of the partially soluble elements, and hence may have an important effect on the color of the oxidized casting. The oxide coating upon a heat-treated casting is usually lighter in color than on a casting not heat treated.

Because of the effect of constituent upon the appearance of the coating, any lack of microscopic homogeneity in the surface structure of the casting may result in a non-uniform, mottled appearance of the coating. Anodically coated die castings may also show the flow lines which follow the course of the metal as it entered the mold. These are due to variations in the structure caused by slight variations in the rate of chill on various parts of the surface. Their elimination or their reduction to a negligible level can sometimes be effected by a change in design of the die and, more particularly, by the selection of an alloy better adapted to receive an anodic coating. A fine sand finish tends to make the flow lines less prominent. In fact, the surface preparation employed prior to anodic coating is an important factor in producing the most attractive finishes.

Anodic coatings can be produced which are porous and will absorb dyes and be colored thereby; they can also be impregnated with mineral pigments by precipitation of the pigment within the pores of the coating. In a similar way, a coating can be given added protection, particularly against salt-containing atmospheres, by sealing in a chromate solution, so that the coating retains within its pores substantial amounts of chromate inhibitor. Coatings sealed in this way usually have a green to yellow color. Other sealing methods are available where coloration is objectionable.

In selecting the alloy best adapted for anodic coating, certain generalizations should be kept in mind. An alloy containing 8 per cent magnesium takes an anodic coating which is light colored and attractive in appearance; the coating is also hard and abrasion resistant. A.S.T.M. alloy VIII (2 per cent copper plus 2 per cent nickel)[5] has a good appearance after anodic coating. Where a dark color is desired, or at least is not objectionable, alloys IV or V (5 per cent and 12 per cent silicon, respectively)[5] may be employed. The substantial silicon contents of these alloys give them a dark color after anodic coating. A.S.T.M. alloy XII (7 per cent copper plus 3 per cent silicon) offers a combination of good casting qualities and a fairly light oxide coating, which can be colored in any except the lighter shades, but has relatively low abrasion resistance.

Evaluation of Oxide Coatings

The tests selected to determine the quality of oxide coatings will be determined by the intended service of the article. Frequently the thickness of the oxide coat is an important criterion, and the measurement of the electrical breakdown voltage of the coating may yield useful information as to this characteristic. The weight of coating per unit area can usually be closely correlated with thickness. Abrasion resistance can be measured by the abrasive air blast method. Salt-spray tests are usually employed for evaluating the protection against corrosion offered by the coating.

Electroplated Finishes

Electroplated coatings applied to aluminum die castings serve two major purposes; they provide ornamentation and may give increased abrasion resistance. Resistance to corrosion is not usually improved by plating. However, for mild service conditions, adherent, serviceable and attractive finishes may be obtained by plating.

The actual plating procedures for aluminum alloys do not depart greatly from those used with other common materials. It is important, however, that a suitable preparatory treatment be given in order to insure adherence of the plate, and it is mainly in the details of this preparatory treatment that the commercial plating methods for aluminum die castings require special consideration.

Surface Preparation for Plating

Acid Etching—A controlled etch has been found effective in promoting the adherence of electroplates to aluminum base metal. The selective action of the reagents used causes certain of the constituents present in the alloys to be dissolved, leaving microscopic pits or cavities in which the plated metal can find anchorage.

4. Protected by patents owned by Aluminum Company of America.

5. Tentative Specifications for Aluminum-Base Alloy Die Castings (B 85-39 T), 1939 Book of A.S.T.M. Standards, Part I, p. 1147.

For die castings, the etching reagent commonly used consists of:

Nitric acid (sp.gr. 1.42) .....3 parts
Hydrofluoric acid (48 to 52 per cent) .....1 part

After polishing and cleaning operations, the parts are immersed in the nitric-hydrofluoric acid solution, at a temperature of 75 to 80° F., for a period of from 15 to 30 sec. They are then carefully rinsed, and are ready for the plating bath.

Important in this procedure is the proper control of immersion time and solution temperature; they should be definitely established by tests and controlled accurately to produce satisfactory results. Constant solution acidity should be maintained by acid additions.

Krome-Alume Process.—The Krome-Alume[6] process has been successfully applied to the commercial plating of aluminum die castings. In this process the article to be plated is first anodically oxidized in oxalic acid electrolyte; alternating current is commonly employed in this step of the process. The oxidation is carried out at voltages increasing from 5 to 50 v. and for a period of about 10 min.

The coating is then treated in a dilute solution of sodium cyanide or hydrofluoric acid By this treatment the coating is "modified" and dissolved; the surface is thereby put in good condition for plating by the usual procedures.

Alrok Process. — Another preparatory treatment for die castings which are to be plated, comprises the oxide coating of the die casting by an Alrok chemical process, followed by treatment of the oxide coated article in a solution of nitric acid. After a final rinse, the castings are ready for plating.

Plating

Nickel is commonly plated directly on aluminum, and may be buffed directly to an attractive finish or may be used as a foundation for other metal plates, particularly chromium. The nickel plating solutions employed are those in general use for the application of nickel electroplating on other metals. They should have good throwing power and give a soft, smooth coating which can be readily buffed to a high lustre. The usual lime buffing compositions may be used. Heat treatment of nickel plated aluminum parts gives improved adhesion of the nickel deposit. For moderate outdoor service, a deposit at least 0.001″ thick is recommended; generally, the thicker the deposit, the greater the resistance to corrosion.

While chromium can be applied directly to aluminum from an ordinary chromium plating bath, the usual practice is to apply it over a preliminary nickel plating. Chromium, when plated over buffed nickel, is more attractive than the duller chromium plate applied directly to aluminum. Heavy deposits of hard chromium plate (0.001″ to 0.010″) are being applied to aluminum die castings to increase their resistance to abrasion. Other metals, such as copper, brass and silver, can be applied over nickel plates. Colored or oxidized finishes can be produced, such as oxidized copper, bronze or antique silver; these finishes, as in the case of other metals plated in the same way, should be protected with a clear lacquer. A black finish can be applied by the Moly-Black process[7], employing a proprietary electrolyte containing salts of molybdenum and nickel.

Painting of Die Castings

Aluminum die castings may be coated with paint or lacquer, either for decoration or for protection against a severely corrosive environment. When decoration is the principal objective, the preparation of the surface is not usually as important a step in satisfactory paint performance as when protective coatings are needed. However, good resistance to impact and handling is often desired, and hence adequate anchoring of the paint to the surface is important. To secure this, solvent cleaning accompanied by light surface roughening may be sufficient.

The different die casting alloys of aluminum show some differences in their ability to hold paint under continued humid conditions, although in general these differences are relatively small. With proper attention to surface preparation good results should be secured on any alloy.

There are a number of ways in which the surface of aluminum die castings may be prepared for painting. As mentioned, solvent cleaning is perhaps the simplest form of surface treatment, and for many applications this may be sufficient. The most effective method of solvent cleaning is that of solvent vapor degreasing. A light roughening of the surface, as by sanding, improves the wearing qualities of the finish.

A still more effective method of surface preparation is chemical treatment with a dilute aqueous solution of phosphoric acid. These solutions are more effective if organic solvents are added to the phosphoric acid. The solvents aid in grease removal and permit ready action of the phosphoric acid, which apparently forms a thin film of protective aluminum phosphate on the surface. There are a number of proprietary treatments of this type available.

Alrok coatings which are applied by a chemical treatment, have been found to be particularly effective on aluminum die castings and they provide an excellent base for the application of paint. These coatings are especially recommended where the service conditions are severe, such as continued service in atmospheres of high humidity. The Pylumin[8] process is a chemical treatment useful in the preparation of the surface for painting. Anodic coatings may also be used under these conditions and in some instances may prove even better. Some of the anodic finishes provide corrosion resistant, adherent impervious oxide films which constitute ideal bases for paint.

Following the surface treatment, the metal must be thoroughly dried before paint can be applied. The castings should be heated to a temperature above the boiling point of water for about 30 to 60 min. to insure complete removal of water left on the surface from any aqueous treatment. This is particularly important if a baking enamel or japan coating is to be applied. The castings should receive a minimum amount of handling after cleaning or treating.

Aluminum die castings are usually painted by either dipping or spraying. The method of application to be employed will be determined by manufacturing considerations, and the de-

6. Krome-Alume Corporation, Lockport, N. Y.

7. Process of E. I. duPont de Nemours & Company, Wilmington, Del.

8. Process of Pyrene Mfg. Company, Newark, N. J.

sign of the casting. Some shapes do not lend themselves readily to a dipping operation.

In most cases, the use of a special priming paint is not necessary when the castings are to be painted solely for decorative purposes. Even in such cases, however, the primer should be one which inherently shows good adhesion and which also permits good adhesion of top coats. The value of any painting system depends, to a large extent, upon the selection of a satisfactory primer. In addition to showing good adhesion, the primer should have good resistance to moisture penetration to prevent surface reaction and should contain an inhibitive pigment. Zinc chromate has been found to show the best corrosion inhibitive properties of any of the pigments which have been tested. Primers in which zinc chromate is the major pigment, if not the only pigment, have been found in most instances to give the best results from the standpoint of protection. Primers of this type are usually made with synthetic resin vehicles which improve their resistance to penetration by moisture. Primers containing lead pigments should not be used in priming aluminum die castings as they have been found to promote corrosion in many cases.

Under most conditions, aluminum paint has been found to be a very satisfactory primer as well as finish coat for use on aluminum die castings. This coating possesses high impermeability to moisture and has good adhesion to the metal.

In many cases it will probably be found desirable to employ baked coatings. The vehicle employed for the primer should, therefore, be one which will withstand baking at a moderate temperature for at least an hour. Properly formulated synthetic resin varnish vehicles of the phenolic or alkyd types have been found to be quite satisfactory for this purpose.

Where pyroxylin lacquer systems are used in finishing the die castings, special primers must be employed, since many types of primers are "lifted" by the powerful solvents used in lacquer formulation.

With the exception of the special lacquer systems, almost any durable paint or enamel may be employed for the finishing coat after the castings are properly primed. If baked finishes are desired, they should be applied over a baked priming coat. Synthetic resin enamels are particularly effective for this use since they can be formulated to give hard, durable finishes quite resistant to moisture penetration. Where the color of aluminum paint is satisfactory, it is especially useful because of its great opacity and high impermeability to moisture.

Where speed of drying is a controlling factor, lacquer systems are suggested. Durable lacquer enamels may be secured in any desired color. The more durable lacquers contain a certain amount of synthetic resin. As previously pointed out, special primers should be employed with lacquer systems.

Another type of finish frequently employed for finishing aluminum die castings is the black baking japan. A single coat is often sufficient, but where greater durability is desired, multiple coats may be employed. The japan coatings are baked at a relatively high temperature (usually in excess of 400° F.) and form very hard, abrasion-resistant films which are also quite resistant to moisture and solvents. Similar coatings may be produced with heat-reactive phenolic resins in a variety of dark colors.

In some cases it is desirable to preserve the natural color and appearance of the aluminum die castings. One way in which this can be accomplished is by the use of clear lacquers or synthetic resin finishes. Special lacquers containing appreciable amounts of light-resisting resins such as methacrylate resins, or containing cellulose esters such as cellulose acetobutyrate, have been developed and are especially suitable for this use. Clear varnishes made with alkyd, urea formaldehyde resins or combinations thereof form very satisfactory finishes of the baking type. They are quite hard and abrasion resistant and do not turn yellow in service.

Cleaning and Maintenance

There are many different reasons for desiring to clean die cast parts. Naturally, the type of cleaning method selected should be determined by the result which it is desired to accomplish.

Surface Renewing Cleaners

For some purposes it is desired to remove the surface layer of metal in order to obtain a pleasing appearance. One such method is the "caustic etch," described in another section of this paper. Other such surface renewing treatments include immersion in cold, dilute (1 to 10 per cent) hydrofluoric acid solutions, in cold solutions containing 10 per cent sulfuric acid and 1 per cent sodium fluoride, or in hot 10 per cent to 20 per cent phosphoric acid solutions.

Safe Cleaners

Surface renewing cleaners should not be used on Alrok or Alumilite-coated articles, or as a rule, on complicated built-up structures, since they will destroy these coatings and are difficult to remove from crevices or other inaccessible regions. Cleaners which cause no appreciable undesirable effect on the articles being treated (that is, safe cleaners) should be employed in such cases. Completely safe cleaners, which can be used in a wide range of concentrations or under widely varying conditions without causing appreciable attack on the aluminum articles being treated, should be used wherever they will satisfactorily accomplish the desired purpose. Most liquid or paste waxes, and most organic solvents (other than the chlorinated hydrocarbons) are completely safe cleaners. Soaps or other alkaline detergents are also often completely safe cleaners, provided they contain a sufficient amount of corrosion inhibitor (such as sodium disilicate or sodium chromate).

Where rapid or powerful cleaning action is desired, alkaline detergents which contain only sufficient inhibitor so that they have no action on the aluminum articles in a limited range of concentrations or conditions can be used. In those cases, the safe operating ranges of such cleaners should be determined by preliminary tests and the cleaners then only employed within safe limits. Chlorinated hydrocarbons, such as ethylene dichloride, trichlorethylene and carbon tetrachloride, can also be classed as partially safe cleaners and must be used with care if undesirable action is to be avoided.

General

In many indoor and some outdoor exposures, bare or Alumilite-coated aluminum die castings require little cleaning or other maintenance in order to retain a pleasing appearance. Periodic dusting or washing with a safe soap is all that is required. Periodic applications of liquid wax are also often satisfactory. In more severe exposures, steel wool can be used in

applying the wax in order that adhering deposits will be removed.

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Oil In Air Line

Question. One of our recent contracts calls for a sprayed finish and we are having a most difficult time in obtaining a good job. Although we have not had any experience in spray painting, we have found the trouble to be oil in the compressed air line. The air comes from a compressor which supplies other parts of the factory. This compressor was recently reconditioned but oil in some manner persists in reaching the spray gun.

We have on order an individual portable compressor for use exclusively on spraying. However, the delivery date is not too certain and in the meantime we must proceed with our order. We will appreciate your suggestions as to what can be done with our present set-up to eliminate the oil. We will be greatly indebted to you for an early reply.

Answer. Our first suggestion is that you purchase an oil and water separator to be placed in the compressed air line at a point just before the spray gun hose. You can very probably secure such a separator from the manufacturer of your spray gun or from his local outlet. In the meantime we strongly recommend that you flush out all the lines with some solvent such as solvent naphtha. Undoubtedly your compressor, before its reconditioning, was passing oil and the lines need to be cleaned thoroughly. Also, if there are none already installed, we suggest that you place a drain at any spot in the line leading to the gun which may be lower than the general level of the piping. These drains should be emptied frequently.

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Finishing Defense Products

By FRANK V. FAULHABER

Brooklyn, N. Y.

The author graphically details and explains various technical problems and methods attending the finishing of shells, bombs and kindred munitions. Much of his helpful, constructive information, vitally related as it is to Defense Production, is also of pertinent use and value in the finishing of other metal products.—Ed.

IN the haste for Defense production it pays to give due time to a good start. This is particularly true as respects the finishing of munitions. No entirely satisfactory finishing job can be executed, however superior and top-ranking the finishing equipment and materials, if the preparatory cleaning has not been complete and thorough. The trace of even an oil will cause the paint to lift. This finishing must be consummated with painstaking precision to comply with exacting Government standards. Therefore, pre-cleaning procedures warrant due consideration.

Practices as followed by such Government arsenals in addition to large private concerns are appropriately representative of the most efficacious methods in vogue and should prove of timely interest to all concerned with this line of work. This is of particular import to the smaller and new-starting plants that may be confronted with the problem of rejects.

The importance of adequate conditioning of the metal surface to be finished cannot be over-stressed, for there are numerous instances where unsatisfactory results attend. Irrespective of how well formulated the paint, it will prove a failure from the standpoint of protection when applied on a wet, dirty, rusty or otherwise inefficiently prepared surface. Rust and scale must be removed, thoroughly, else corrosion may continue under the paint film, since rust and scale absorb and retain moisture. Whenever moisture is sealed in by the paint coating, corrosion is a natural sequence.

Shell Interiors

An initial cleaning of shell interiors preparatory to nosing, machining and inclusion of a rotating band, is by way of a shot or sand blast or pickling operation, to eliminate adhering scale. This first groundwork makes for better adhesion of the finishing material, and prevents any abnormal chemical action that may spread and result in the finish blistering or flaking off. Oils, greases and grime cause similar harmful effects. Foreign substances, such as abrasives and metal particles, resident on the finishing surface, will emerge through a thin finishing film, resulting in an objectionable, unsatisfactory rough surface. It must be borne in mind that the cleaning of shell interiors at all points is vital, since the final finishing coat must meet exacting Government requirements, revealing perfect adherence.

Plants operating on small scale, may remove rust by wirebrushing, sandpapering, or steel-scraping. Light rust coatings are pickled in a solution made of commercial sulphuric acid diluted in water. There are many other metal cleaning methods and various cleaning compounds, all more or less effective, but sand-blasting is as efficient as any for rust and scale removal.

The sand-blasting procedure is a favorite because it keeps the working surface dry. It enables the plant to produce a smooth, clean surface. It can also be used for removing old finishes and bad coats, in re-working rejects.

The efficacy of a sand-blast machine is governed by a number of factors.

The nature and condition of the working surface prior to sand-blasting, the quality and fineness of the abrasives employed, the air pressure of the equipment, the proficiency of the operation, and the thoroughness with which the work is done, all must be considered.

After Machining

After the shells have been formed in the machining department, the work must undergo another cleaning, there being a residue of oil, grease, metal particles, and other substances acquired during the operations. Cutting compounds and lubricants used as coolants in machining the work are particularly difficult to remove. It is their very adhering qualities that make these materials desirable, since these are intended to lessen friction on the tools. Nevertheless, once the product is conveyed to the cleaning department, every last vestige of these greasy matters must be obliterated.

Animal and vegetable oils are incorporated in these compounds, by reason of their high film-forming properties, contrary to ordinary mineral oils. No given cleaner will serve for all cleaning purposes, but there is a range of varied metal cleaners that are efficient for thorough shell cleaning.

The cleaning medium must consist of such components conducing to rapid emulsification of all types of oils, while at the same time of low caustic content.

A cleaner with caustic potency is viewed disfavorably from an operating standpoint, because these are never entirely satisfactory for all purposes and employees generally dislike to use them. A cleaner of high caustic strength will dissolve the zinc from brass surfaces and have pitting tendencies. An appropriate cleaner is one containing the proper emulsifying and saponifying materials. Besides expeditiously cleaning the shells of all oils and soaps usually on such units, such a cleaner will also rinse easily,

leaving a chemically clean surface. Contrariwise, caustic cleaners involve rinsing difficulties, conducing to residue remainders on the shells, with incident staining and tarnishing that will prevent proper anchorage and adhesion of the finish to the metal.

Overly concerned in this matter of rinsing, incidentally, finishing executives cannot be, for the metal surfaces must be freed of all traces of fabrication and cleaning materials if there is to be correct binding of finish to metal. Even though a shell under ordinary conditions might represent a superbly finished article, in appearances, a minute detrimental influence might be sufficient to render said shell imperfect and disserviceable. The shells should be rinsed in clear water, maintained, preferably, at near boilingpoint. The hotter the rinse, the speedier the drying. One procedure is to employ two rinse tanks, making for a practically clean rinse in the first tank, thence dipping in a second clean rinse. The ends demanded and sought, that of thoroughly chemically clean and complete rinsing, are thus more certain as likely with but a single rinse. With only a one rinse tank there is the hazard of alkali residues being carried over to leave objectionable stains on the product. Of relevant importance, incidentally, is the matter of water, which cannot be too clean, and should be changed frequently enough whenever suspected of impurity, requisite for the work.

Agitation Cleaning

When using a still cleaning tank, the heating arrangement should be such as to permit the cleaned shells to be withdrawn through a clean solution. When heating, it is best not to let the live steam interfere with the solution, since condensation by the steam tends to dilute a mixture and the operator thus may be in doubt of its true concentration. Shells are usually left in the solution approximately five minutes, preferably in a horizontal position, so that the interiors undergo thorough cleaning. The work can be expedited by agitation, or, sometimes the operator swirls the shells about with tongs or rod, and otherwise manipulates them so that each unit is completely cleaned, innerly and exteriorly, before withdrawn and drained and then readied for a final hot rinse to remove any remaining traces of cleaner.

With automatic cleaning machines, used for large volume output, and depending on the shells, the action of the cleaning solution is facilitated, and usually less cleaner per gallon is required. There are various bearing factors, depending upon the nature of the work, the character of oils and compounds to be removed, and the rate of speed the units are processed. Various spraying arrangements operate in conjunction with mechanical cleaning machines, the object here being to make for thorough cleaning, washing and rinsing of the shells. Here, too, whenever the cleaning mixture appears contaminated it should be renewed. Some plants dump cleaning solutions, periodically, say weekly, while others will refreshen the set-up whenever the occasion seems advisable.

Accelerating Drying

Inasmuch as automatic cleaning systems generally operate at a set schedule, the cleaners in use should be the most proficient attuned for the work, so that this cleaning will be performed efficiently without interfering with the rate of flow. In some instances cold water is used for rinsing, but the hot spray method generally seems in favor, promotive as it is for a more thorough cleaning and a rinse that accelerates the drying process.

In some instances where cleaning troubles are encountered, the difficulty may be resident in the water used. Stains sometimes show up in the work that may be traced to the hardness of the water. After evaporation, white spots will crop up, here and there, these deposits interfering with the finish as it is applied. This perplexity sometimes can be overcome by operating an air spray between the rinsing operation and drying oven. This quickens drying to the extent it does not permit the salts in the water to accumulate on the surface of the shells.

Whenever doubt prevails regarding the qualities of the water being used for cleaning, it may prove advisable to resort to a "water break" test. Sometimes, when the cleaning or the water is under question, there is recourse to a cleaning and copper plating test to rule out the trouble, but the water break method is speedy and simple, it requiring but the rinsing of a metal shell, then dipping it in cold water. If the liquid does not run off uniformly as the shell is withdrawn, tending to break in spots, it is evident that the shell is not chemically clean.

Testing and Uniforming

In some plants it is periodic practice thus to test a cleaner, daily, since the character of the work and processing varies so frequently, thereby being enabled to intercept delinquencies and better uniforming the work. Operations are more certain and there is less likelihood of complaints emanating, perhaps months hence, of the finish disintegrating.

For one finishing reason or another there will be rejects of shells. In renovation plants, it is customary to run the old painted projectiles, after removal of explosives, through a sandblasting machine to remove paint, etc. However, there are also paint and lacquer strippers for the re-servicing of shells approximately ½ lb.

Care, incidentally, should be exercised by the stripping operator against eye injury by wearing goggles and otherwise being equipped with suitable clothes for this work. A portable outfit for this stripping purpose may be used, or the plant maintenance men may be able to rig up a workable arrangement whereby the work may be undertaken effectively.

Here, as with spraying of finish, a certain technique is entailed so that the operation will progress properly without slubbering through the job. The stripping gun, preferably, should be held one or two inches from the surface, and the action of the spray naturally will also be controlled by the size of the nozzle, the hose, as by the pressure. For shell stripping, the gun should be equipped with a round nozzle tip, the spray thus being more confined and not widening as would be the case with a flat tip. Some operators, however, prefer a bent nozzle tip, asserting manipulation is less tedious for correct stripping.

Proper stripping equipment, naturally, will make this work less irksome than may appear, but in the selection of the necessary apparatus, consideration, of course, should be given to such details as convenient use, ease of operation, and efficient stripping.

After Stripping

When spoiled or rejected shells have been stripped entirely of the finish, they are then given a hot rinse to completely free them of all foreign matter, and thence readied for re-finishing

as with the regular run of work. The stripping gun should be retained in efficient condition, some stripping materials, incidentally, tending to clog the gun, and when this phase is accorded proper attention, the selection of superior strippers and maintenance of good operating equipment will more forehandedly be solved.

Once the shells have received the final cleaning, it is desirable to proceed directly with the finishing. Naturally the location of the shell finishing department and spray coating equipment is important and should receive due consideration. The layout should be so arranged that the shells will reach the spraying department while they are still warm or hot from the degreasing or final cleaning operation. This facilitates drying of both the interior and exterior coating. Other procedures, naturally, will be assistive such as the use of infra-red ray lamps, steam, gas or electric ovens, where the rate of production or the character of the coating material requires. Incidentally, a minimum of handling prior to paint application will make for the desired coating, as rust spots will result from perspiration moisture.

Appropriate exhaust equipment, either of the dry or water wash type, represent an integral part of the complete automatic shell coating machine and adequate exhaust facilities should be provided at any manual operated or semi-automatic spraying station.

The matter of preheating is vital from various angles. A metal surface to be painted should be at room temperature, approximately 70° F. Frequently shells have been brought to the spray booth direct from a freight car at zero temperature or below. After spraying, blushing or blooming was quite pronounced. Preheating solves this difficulty. Preparatorily, it would be well to have a reserve supply of finishing materials stored in a special room, as warm or almost as warm as the finishing room, so that materials will always be in workable condition for immediate use. Not only is the consistency of many finishing materials affected by the cold, incidentally, but moisture may be condensed from the air inside partially filled cold metal containers when these are transferred to a warm room.

Operating Atmosphere

Pertinent, also, is the matter of all metal coming in contact with the finishing materials and the air with which these materials are sprayed. Compressed air lines, spray guns, metal racks and metal surfaces to be sprayed should be at comfortable room temperature while any finishing work is in progress, if operations are to be successful.

On the inside of projectiles it is customary to apply a black asphaltum paint. A good grade is required, as an inferior product will result in runs, especially in warm weather, and would entail the application of from three to four coats to obtain a finish that would pass inspection. The viscosity, incidentally, should be checked periodically to insure uniform results.

Lacquers usually are procured on the basis of their solid content, with little necessity for thinning. Nevertheless there are various factors that may vary the consistency of lacquers. Cold finishing materials, for instance, will run high in viscosity and require too much thinner to cut to the required working body. The addition of a thinner to a cold finishing material, incidentally, may tend to separate the resin and pigment. A goodly percentage of paint finishing troubles, it may be noted, occur during cold weather.

The importance of proper conistency of a lacquer, in finishing shells, must not only be considered from its spraying or working qualities, but in its ability to apply the correct thickness of film for the work. The matter of over-reducing a finishing material to achieve greater spreading power, in shell work, would prove misguided economy. Hence the importance of viscosity tests.

The Ford Cup Test

There are various efficacious determinants for this purpose. One that is widely in use in finishing circles and that has the added merits of being both simple and inexpensive, is by way of the Ford cup. The cup is standard as to size of aperture and as to contents and can be procured from concerns specializing in scientific instruments. In conducting this test a stop-watch is used as a timer. The cup is a hollowed steel cylinder, formed cone-wise at the bottom, with an opening at the bottom. For testing, it is merely necessary to fill the cup with finishing liquid to the very top, a finger closed over the hole at the bottom.

The finger is then released, to permit the cup to empty into the graduated glass container underneath, meanwhile timing until the cylinder or cup is completely void of the material. If the finishing liquid drains in less than the specified rate, it is an indication that it is too thin; a longer time would reveal it as too heavy. The Ford cup is serviceable for testing both clear and opaque lacquers. In undertaking such a test, attention should be given to the correct temperature of the lacquers.

(To be continued in May issue)

Spray Gun Nozzle

U. S. Pat. 2,269,067 A. F. Jenkins, Jan. 6, 1942. A nozzle assembly of novel design for spray guns.

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NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

Transparent Finishes for Metals

A colored transparent finish for use on polished metal, which is unaffected by wartime restrictions, is being produced by Maas & Waldstein Company, Newark, N. J., as a substitute for electroplating and bronze-powder finishes.

This finish, which is marketed as "Plate-lustre," consists of a concentrated enamel, of the desired color, added to a clear lacquer. When applied on polished metals, it makes them resemble copper, brass, bronze, color-treated aluminum and steel, or other metals, according to the manufacturer.

It is applied by spraying or roller coating and can be furnished for either air drying or baking. Flat stock finished with certain grades can be formed after baking. Two-color finishes can be obtained by "relieving" operations. The colors are fast to light in indoor service, the manufacturer states.

Luminous "Blackout" Paint

A luminous "blackout" paint, which can be applied to objects of all kinds and renders them visible in the dark, has been developed by Maas & Waldstein Company, makers of industrial finishes, Newark, N. J.

Unlike the radio-active finishes commonly used on watch dials, the new paint owes its luminosity to a substance which re-radiates light, according to the manufacturer. It contains no toxic materials. After the paint has been exposed to either daylight or ordinary electric illumination for a few minutes, it glows for about 20 hours and repeats the action after re-exposure.

The new paint, which is known as "Durad Luminous Paint," must be used over a special primer and thinned out with a special thinner, both of which are supplied with the paint. One thick coat, or, preferably, several thin coats, of the paint produces a flat white finish suitable for indoor service. For a glossy finish, or for outdoor service, the paint is covered with a special clear topcoat. Each coat air dries in from 1 to 4 hours depending upon weather and other conditions.

Whirl Enameler

Ronci Machine Co., 45 River Ave., Providence, R. I., has just issued a 4-page bulletin describing two of their whirl enamelers, namely, Models R-100 and R-200.

These instruments have been designed for applying organic finishing materials, such as lacquers, enamels and paints to small parts by first dipping in baskets and then following by whirling in the company's whirl enameler. The technique is stated to be suitable for organic finishing of both metal and wood.

The R-100 enameler has a work basket with a capacity of 312 cu. in., which is run by a ⅓ H.P., General Electric flame-proof motor. The total weight is approximately 550 lb. The R-200 enameler has a work basket of 1206 cu. in. capacity. It has a ½ H.P. General Electric explosive-proof motor for spinning and a ⅓ H.P. General Electric explosive-proof motor for hydraulic lift. Its weight is approximately 1000 lb.

Coating for Glass

To prevent injury caused by flying pieces of glass broken by vibration, which are always responsible for the largest number of casualties during bombing raids, a transparent protective coating for windows has been developed by Maas & Waldstein Company, makers of industrial finishes, Newark, N. J.

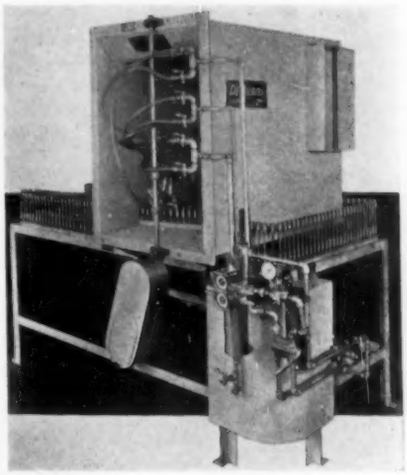
Window glass or plate glass treated with this new coating, which is known as "Glasshield," is in effect turned into safety glass. A coated pane may break as the result of vibration but it does not shatter, according to the manufacturer. It is also stated that the coating does not interfere with vision or light transmission through the glass.

Two coats of Glasshield on the inside surface of a window pane are effective, but, for maximum protection, the outside surface should be similarly treated, the manufacturer states. The coating is applied with a brush, allowing an hour for the first coat to dry before the second one is added. When no longer wanted, the coatings can be removed with a razor blade.

An Automatic Machine For Painting Small Shells

One of the more recent developments in equipment for painting small shells is a standardized automatic machine for small shell and shell parts made by The DeVilbiss Co., Toledo, Ohio. The one illustrated coats the exterior of 20 mm. shell at a rate of 2,000 per hour.

This machine is built around a "chain-on-edge", variable speed conveyor which is of sufficient length to allow for a ten minute drying time at a production rate of 1,000 shells per hour or a five minute drying time at a production rate of 2,000 shells per hour. Spindles for supporting the shells are of the removable type and are equipped with flat surface pulleys for rotation inside the spray booth. Spindle rotation is by means of a separate variable speed drive. Workholders for the shell mount on the spindles.



Automatic machine for painting small shells.

Spray guns are the automatic air piston type with adjustable cam operated spray control. Ten gallon pressure feed paint tank is equipped with air motor driven agitator. Spray booth, exhaust fan, air transformer and the necessary air and fluid hose, control valves, fittings and connections complete the machine.

Machines of this type are now in use in the painting of the several classifications of 20 mm. shells, 20 mm. practice shot, 20 mm. fuses and fuse bodies.

Steel Treating Material

Protective Coatings, Inc., 10391 Northlawn, Detroit, Mich., have announced the development of a treating fluid, called "Deox-X," which is applied to steel to inhibit oxidation. It is claimed that excellent salt spray life is obtained on steel coated with this material, and also that the treated surface acts as a good undercoat for organic finishes.

The solution is supplied as a thin liquid which can be applied either warm or cold and by dipping, brushing, spraying or wiping with a cloth dampened with the solution.

The solution is also recommended for treating galvanized sheets as well as steel.

The DeVilbiss Company has moved its St. Louis, Missouri Sales and Service Branch to 2737 Washington Avenue.

This new location with its improved parking facilities will make it more convenient for the trade to take advantage of the services offered by the company's St. Louis branch.

Communications

On Vacuum Equipment for Solids Determination

WILSON-JONES COMPANY
ELIZABETH, N. J.

Gentlemen:

In your December 1941 issue there appeared an article on solids determination utilizing vacuum equipment. Mr. James G. Shelton was the author of the article.

In the main the article was sound and correct but the last paragraph in the article was entirely wrong and anyone not familiar with the use of vacuum equipment would be in for sad disappointments if he took this last paragraph for correct.

In the first place a water pump aspirator should never be used for this purpose without interposing a trap between the pump and the apparatus to prevent the "sucking back" that occurs when a fluctuation occurs in the water pressure. No mention is made of this first principle in vacuum technique. The cabinet shown in the article is not a vacuum cabinet at all—it is a sterilizing cabinet such as is used by barbers to sterilize combs, etc., with formaldehyde gas. It can and has been used for a desiccator but it will absolutely not hold a vacuum. It must be remembered that an apparatus under vacuum must resist an outside pressure of almost 15 pounds per square inch at full vacuum. Quite obviously all surfaces must either be curved or of very heavy metal to withstand this pressure. The cabinet illustrated would have the glass in it broken before 15 inches of vacuum was pulled.

The author, more than likely, has never used vacuum equipment to any extent. In a series of determinations somewhat similar to the one mentioned in the article, I made use of pyrex test tubes immersed in liquid heated to the desired temperature; a rubber stopper fitted with glass tubes connected to the source of vacuum—suitably trapped. With this arrangement it was possible to run one or a hundred determinations at the same time.

Very truly yours,
R. R. Uhrmacher,
Former member of staff,
Massachusetts Institute of Technology.

Mr. Shelton's Reply

Dear Dr. Meyer:

"Relative to Mr. Uhrmacher's comments in his letter of December 27, he is quite right in his statement that a trap should be used. Neglecting to include this point was a very serious error.

With regard to the cabinet, it is obviously not one suited to uses where complete or nearly complete vacuum is desired. However, the method does not require complete vacuum. A little thought will show that partial vacuum may be used in which case heavy, curved wall construction is not essential. The fault is undoubtedly mine in using the term vacuum where the term reduced pressure should have been employed. This usage is one which many technical men fall into after having been out in industry for a number of years and having had associated with plumbers and steam fitters to whom anything less than normal pressure is termed a vacuum.

I am happy that Mr. Uhrmacher agrees that the method is a sound one. His statement that the method is correct is extremely gratifying, particularly since it comes from one who has used a similar procedure and who has obviously had considerable experience with vacuum equipment."

Very truly yours,
James G. Shelton

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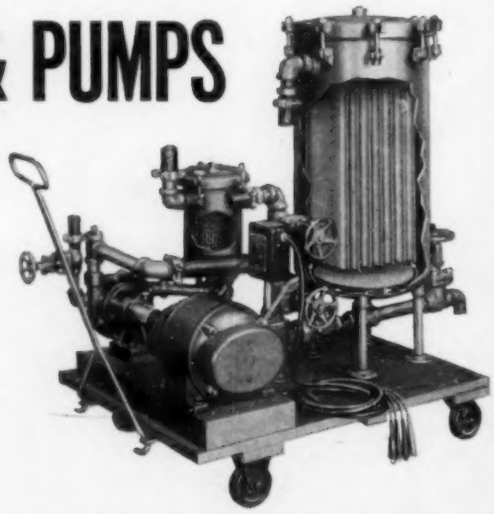

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METAL FINISHING

VOLUME 40 MAY 1942 NUMBER 5

Publication Office:
116 John Street, New York

L. H. LANGDON
Publisher

THOMAS A. TRUMBOUR
Business Manager

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Editor

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PUBLISHED MONTHLY—Copyright 1942 by The Metal Industry Publishing Company, Incorporated, 116 John St., New York, N. Y. Entered February 25, 1903, at New York, N. Y., as second class matter under Act of Congress, March 3, 1879. Re-entered as second class matter June 13, 1940, at the post office at New York, N. Y., under the Act of March 3, 1879.

SUBSCRIPTION PRICES: United States, $2.00 per year; Canada, $2.50 per year (includes 50c exchange and tax). Foreign $5.00. Single copies 25c. Please remit by check or money order; cash should be registered.

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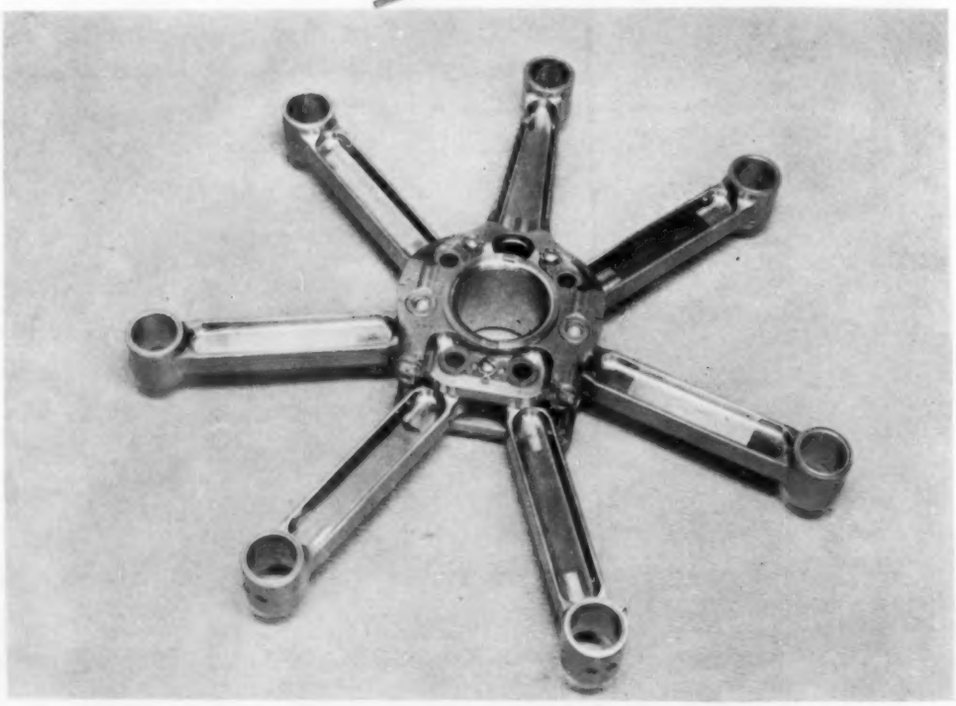

Connecting rods, such as illustrated, are typical of the many engine and plane parts on which the Lea Method of Polishing and Burring is being successfully used.

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Specialists in the Production of Clean-Working Buffing and Polishing Compounds

VOL. 40, NO. 5 METAL FINISHING MAY, 1942
PREPARATION, ELECTROPLATING, COATING

Save Plating Materials

The importance of saving metals and supplies used in the plating industry has been mentioned before but because of the shortages existent, we are again emphasizing methods of saving.

Save drag-out—analyze your solutions regularly to prevent excessive build-up—rack the work to give the best possible drainage of solution.

Rack your work to get the most uniform distribution of plate possible. In this connection, the intermediary anode principle may be of help.

Stop bright dipping of zinc and cadmium deposits. Bright appearance is usually not required in plating war goods and bright dipping removes from 5 to 20% of either zinc or cadmium plate.

Save power by conserving steam used in heating water or solutions. Check your motor-generator to get highest efficiency and consider efficiency when buying current generating equipment.

WPB Orders

From the many letters that we have received in the past few weeks, it appears that there are misunderstandings in industry regarding the various restriction orders on plating, issued by the War Production Board. Some have been of the impression that as long as they did not receive a copy of the restriction directly, then they could continue with the practice of plating until a direct order was received from Washington. As a general principle, it should be noted that ignorance of the law is not a valid reason for disobeying the same.

METAL FINISHING has attempted to summarize, each month, the important orders relating to the electroplating field, and a summary of these orders was presented in the April issue. The manufacturer can have his name placed on the mailings of the War Production Board, and the various orders are summarized in many local newspapers. In case an interpretation of an order is desired, we suggest first contacting your local WPB office, and if the necessary clarification cannot be obtained from the local office, then write to the proper section head in Washington. At present there are limitation orders applying to the plating of nickel, cobalt, copper, tin, lead and rhodium. In some cases, the order limits the use of one of these metals and may not specifically refer to plating.

The following metals can still be plated if the plater has them on hand: Chromium, gold, iron, platinum, silver and zinc.

Black Market Operations in Scarce Chemicals

We have nothing but contempt for those dealers in chemicals and plating supplies who have taken advantage of their fellow countrymen by charging exorbitant prices for goods made short by our War Effort. It may be "smart business" to buy up quantities of chemicals or materials, either legitimately or not, and then sell them at from 200 to 500% profit, but it has the earmarks of low carpet bagging.

A recent release of the War Production Board brought the welcome news that Uncle Sam is at last clamping down on "black market" operators in scarce chemicals. The elimination of chemical racketeers depends upon the cooperation of all who purchase chemicals. Report cases coming to your attention to the War Production Board and a fair investigation will be made by one of their investigators. Let us stamp out the practice of profiting at the expense of others' misfortunes.

Defense Highlights

Use of tinplate and terneplate as closures for glass containers was brought under the control of WPB by issuance of Conservation Order M-104 on April 3, 1942. Cover caps made of tin or terneplate for special purposes were barred, and further reductions in tin for closures are expected to result from the development of better coating materials which will allow more foods to be packed without tinplate.

The jewelry industry was granted until May 15th to use up such of its copper in inventory that has been plated or alloyed with gold or silver. This permission was granted in Supplementary Conservation Order M-9-c-2, issued April 4. The allowance was made because of the difficulty in separating the copper from the alloyed gold or silver.

Tin content of solder was restricted to not more than 16% in Order M-43-a amended March 17.

The relative scarcity of certain materials was made public in a report issued by Harvey A. Anderson, chief of the Bureau of Industrial Conservation of WPB. Included in the list of materials most vitally needed for war purposes and in general not available for civilian needs are: alloy steel, aluminum, aluminum scrap, cadmium, calcium-silicon, chromium, cobalt, copper, copper scrap, iridium, iron alloys, magnesium, nickel, nickel scrap, rhodium, tin, tinplate and terneplate, tungsten and tungsten carbides, vanadium, wrought iron, zinc (high grade), acetone, alcohol (methyl), chlorinated hydrocarbon solvents, chlorine, phenol formaldehyde, resins and plastics, phenol, phosphates (tricresyl, triphenyl), phthalic anhydride and phthlates, polyvinyl chloride, sodium nitrate (pure), toluol, corundum, cotton duck, palm oil, rubber, shellac and tung oil.

Many limitation orders were issued during the month suspending the manufacture of certain objects, and a complete list of the limitation orders and prohibition dates can be secured from WPB. Included among the objects whose production will be curtailed or limited, were metal office furniture, kitchen and household articles, automatic phonographs, weighing and amusement machines, electrical appliances, slide fasteners, golf clubs, radios, plumbing and heating equipment, oil burners and coal stokers, laundry and dry cleaning machinery, metal household furniture, bicycles, metal signs, office supplies, such as paper clips, thumb-tacks, pencil sharpeners, outboard motors and fluorescent lights. In some cases, production will be reduced, and in others, completely curtailed.

All use of rhodium in the manufacture of jewelry was prohibited in amendment No. 1 to Order M-95 issued April 17, 1942. The original order issued March 11th stopped the electroplating of rhodium on jewelry but did not affect its use in alloy or other forms. However, rhodium solutions and rhodium stocks on hand can be used up. The important war use of rhodium is to coat reflectors in anti-aircraft searchlights and for certain catalytic purposes.

Deliveries of iron and steel products will be restricted to preference ratings of A-10 or higher after May 15, as of Order M-21 as amended April 21, 1942. The order formerly applied to steel products only and the inclusion of iron means that the 2700 iron foundries in the country must comply with its provisions.

Silver in Place of Fine Copper Wire

Fine silver wire promises to replace fine copper wire for small coils used in thousands of electrical applications, in the opinion of investigators with Handy & Harman who now have charge of the American Silver Producers' Research Project. This is partly because silver is plentiful, whereas there is a great shortage of copper and its use in now being largely restricted to defense needs. In addition, however, silver has the highest electrical conductivity of any metal.

Naturally, silver costs much more than copper **per pound**, but the difference in metal cost for enough fine wire for small coils is small, especially in relation to total cost. The latter is only slightly altered, since labor and other factors involved in total cost are large as against material cost. Silver's high resistance to corrosion is also a factor in electrical applications and accounts for a growing use of silver in electrical equipment.

Tin Cans for Copper Leaching

New plans were announced for the construction of three plants in the Southwest, where used tin cans will be prepared for a leaching process in the precipitation of copper from leach waters. Can collections will be made in the cities containing these plants, namely, Dallas and Houston, Texas, and Kansas City, Mo.

Poster on Cover

The poster shown on the front cover is one prepared by the British and American Ambulance Corps, Inc., 420 Lexington Ave., New York, N. Y. A series of ten of these posters, all different, are available for distribution in the interests of national defense, and as a means of obtaining funds for ambulances wherever needed. Permission for this reproduction was obtained by Hanson-Van Winkle-Munning Company.

These posters are obtainable by contacting the British and American Ambulance Corp., Inc. and cost 15c for one, two for 25c, or in larger quantities starting at 10c each and at lower prices as the numbers wanted increase. They are particularly adaptable for office and plant bulletin board use.

The Polishing of Steel by Electrolytic Methods*

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In view of the advantages of electrolytic polishing preceding the plating of steel or iron, a series of tests was run in order to find the best methods and baths to give a satisfactory polish. Optimum conditions to produce polish were determined with the aid of a photoelectric reflectometer.

It was found that for metallographic sample work, a solution of 76.5% acetic anhydride and 18.5% perchloric acid by volume gave the maximum polish, but for commercial work preceding plating a solution of 60% phosphoric acid and 20% sulfuric acid gave the best results. The method of operation and the apparatus used are described and discussed. Suggestions for further experimental work in electropolishing are made.

Introduction

IN the metal finishing industry, the surfaces of metal objects and plates must be prepared so as to be suitable for the final finish desired. The various finishes require different preliminary treatments such as: (1) Priming for paint finishes to prevent oxidation continuing between paint film and surface, in this way assuring a good bond, (2) Copper plating before nickel plating to assure a good bond, (3) Degreasing before lacquer spraying, etc.

In the plating industry the present method is to make a surface mechanically and chemically clean, plating the desired metals, and then following up the last plating with a mechanical polishing, such as burnishing, buffing or similar procedure. Since the casting, hot working, annealing or heat treating of common metals develop an oxide film, this must be removed before plating or finishing. Three methods are commonly used for this purpose.

1. Acid pickling
2. Sand or metal shot blasting
3. Grinding

The acid pickling method consists of immersing the metal in a weak acid solution for a sufficiently long period to dissolve off oxide film. In order to keep from attacking the metal, inhibitors are added; time also must be controlled.

Sand blasting consists of directing a stream of compressed air and sand particles against the metal. Thus it is cleaning mechanically. The disadvantages of this method are the necessity of having clean sharp sand (reuse of sand causes rounding of corners and thereby effectiveness of cleaning), and the occupational disease hazards. Operators engaged in sand blasting are subject to silicosis caused by fine dust entering the lungs. In order to overcome this hazard, the tendency has been to switch to metal shot blasting, particles of metal replacing the particles of sand in the air stream.

The grinding procedure is applicable to relatively simple surfaces and cannot be used on all irregularly shaped surfaces or objects. The grinding is accomplished by rotating an abrasive stone or wheel against the surface of the metal, thus tearing off the oxide film. This method is most generally used where the film of oxide is very thick.

After the cleaning as per one of the above methods, the surface has to be finished, the finishing being for any or all of the following reasons:

1. Appearance
2. Preparation for other coating
3. Preservation of surface
4. Preservation of whole

The methods used for polishing may be split into two groups:

(A) Polishing without metal removal.

(B) Polishing with the removal of metal taking place.

The polishing without metal removal is accomplished by cold rolling or by burnishing. The cold rolling of a metal sheet may cause laps and folds, especially if surface is uneven to start. The burnishing of metal surfaces may leave porous spots especially with the harder metals. In the burnishing operation the higher portions are hammered down and spread out, and unless the various hammered surfaces fuse or conglomerate together, the interstices present a point of entrance for oxidation to start.

Finishing with the removal of metal is done by cutting, polishing or buffing. In cutting, the surface is actually removed by a cutting tool, a sharp hard piece of metal shaving off the surface.

Polishing or buffing will remove a portion of the surface, but in smaller proportion than cutting. The finishing action is obtained by the rubbing of finely divided abrasives over the surface either in powder or paste form or imbedded in cloth such as buffing wheels.

In order to cut down the labor required and thus reduce costs of finishing, various methods have been tried or suggested. One of the proposed methods for finshing of steel is to take the steel as it comes from the mill and either clean roughly or take it as is and polish it electrolytically. This would give a highly polished surface that could be plated either with bright nickel direct or with bright copper followed by nickel and obtain a finished surface without the need of any further work.

* This material has been submitted in partial fulfillment of the required work for the degree of "Master of Chemical Engineering" at the Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

TABLE I
Baths Used for Electrolytic Polishing of Stainless Steel

1	2	3	4	5	6	7
Blaut & Lang	*Allegheny-Ludlum*	*Burns & Warner*	*Fink & Kenny*	*Keloie*	*Larsen*	*Quintin Marino*
Phosphoric	70%	70% H_3PO_4	42½%	15% H_3PO_4	50% H_2SO_4	15° Bé H_2SO_4
Sulfuric	Phosphoric		Chromic		36% HNO_3	$Ca_3(PO_4)_2$
3 amps./sq. in					14% H_3PO_4	$Ca_3(PO_4)_2$ & H_3PO_4
4 min.						Na_2SO_4 added to
5 min.	3 amp./sq. in.	100 amp./sq. ft.	0.06 amp./sq. cm.	6½-6¾ volts		saturation
7 min.	5 min.	3 min.	0.39 amp./sq. in.	Lead elect.	No current	100 amp./sq. ft.
Lead lined tanks			1 hour	10 sec. anode	5 min.	1½ min. as anode
Heating & cooling coils				15 sec. off		1½ min. as cathode
Copper racks				10 sec. cathode		Room temp.
Pb or Cu cathodes				15 sec. off		
6—12 volt generator				Repeat 5 times		
4 to 10 min.				(3 min.)		
1 to 5 amp./sq. in.						

It had been observed by Jacquet[15] and others that a very high polish can be obtained on metal surfaces by electrolytic methods. The observations were in connection with polishing of metallographic samples, and, therefore, electrolytes and methods used do not lend themselves to commercial practice. Thus, for example, Jacquet's method of polishing steel requires a bath consisting of perchloric acid and acetic anhydride at temperatures lower than normal room temperature. Other than this work on metallographic samples, little was done until stainless steel came into common use.

With stainless steel, the difficulties of mechanical polishing became more acute due to the hardness of the metal and the dangers of local overheating. The metal's value lies in the formation of a chromic oxide film and its complexes on the surface. This oxide is very hard and, therefore, requires excessive time, pressures and special equipment for polishing. This polishing at high pressures and for long periods of time often causes local overheating which may cause a breakdown of the protective film formed and thus cause rusting and pitting. Due to these difficulties and the resultant high cost, other means of polishing were sought. There are now several accepted baths for electrolytic polishing of stainless steels which are used by many major producers.

After the success achieved in this phase, attention was turned to polishing other metals such as brass and copper electrolytically, but apparently little work was done on ordinary steels. Uhlig[36] mentions difficulties encountered in polishing iron and steel due to varying heat treatment and carbon content, and several other authors mention it only in passing. It was, therefore, decided to run a series of tests in order to determine the optimum conditions for the polishing of ordinary steel as the first step in the suggested process of preceding plating with electrolytic polishing as against present practice of plating and then polishing mechanically.

Previous Work

In the working of metals (rolling, heat treatment, etc.) an oxide film is formed on the surface. This film is usually removed by dipping the metal in an acid solution until the oxide is removed, the process being called pickling. In order to speed up this process, electric current was applied, making the metal surface anodic.† The first records of this electropickling date back to 1915. Electropolishing is a form of electropickling and the first apparent notice of it was in 1925 when Madsen[22] discovered that a high acid solution, 86 to 92% sulfuric acid, run at current densities from 17 to 100 amperes per sq. ft. at a temperature of 130° F. for one to three minutes, gave a surface that was much whiter and more pearly than that obtained by usual pickling methods. The voltage required was 42 volts.

A similar phenomenon was reported by Pederson[23] using a lower acid content. Pederson obtained a clear gray metallic lustre and also observed that this surface could be readily electroplated. This confirms the discussion under theory that bright surfaces obtained by electropolishing can be readily plated, whereas Pinner[37] shows that cold rolled bright steel when plated with nickel gave better results than if it were polished and buffed by use of usual mechanical methods preceding plating.

Difficulties in plating of mechanically polished surfaces are also reported by Hothersall and Hammond[38] who found that among the five major causes of porosity in electroplated coatings was surface roughness of the base metal.

The electrolytic polishing of metals was not followed up commercially and there appears to have been little done on electropolishing until 1935. The next few years showed considerable work by Jacquet and associates[1,2,3,4,5,6,8,12,15] dealing chiefly with metallographic samples. The first records are of polishing copper by anodic treatment in phosphoric acid electrolytes. Various metals and baths are covered, and in 1939 Jacquet[15] succeeded in polishing metallographic samples of steel using a bath of 76½% acetic anhydride, 18½% perchloric acid, 5% distilled water and small amounts of aluminum. In his experiments, Jacquet[2,4,5] observed that the current density had to be adjusted to give a condition between passivity and corrosion at the anode surface. The polishing action apparently was obtained by compounds accumulating in the depressions of the surface and passivity prevailing at these points, whereas the high points were exposed and, therefore, were corroded. The results were a smooth, mirror-like surface.

With the increasing use of stainless steel, active attention was turned to electropolishing due to difficulties in

† Editor's Note.—Anodic pickling is usually not used for removing heavy scale but rather to remove smut and brighten the surface after non-electrolytic or cathodic picking or descaling.

TABLE II

Electrolytic Polishing of Metals

Metal	*Solution*	*Current Density Amps./sq. dm.*	*Externally Applied Voltage*	*Temp. °C*	*Min. Time*	*Remarks*	*Reference*
All carbon steels Martensitic Pearlitic Sorbitic	Acetic anhydride—765 cc. Perchloric acid—185 cc. Sp. Gr. 1.61 (65%) Distilled H_2O—50 cc. 0.5% Al	4 to 6	50	30	4 to 5	Prepare solution 24 hours before using. Use moderate agitation. Al increases viscosity which permits more vigorous agitation & current density of 3 amp./dm.^{2} Can use at C.D. of 10 for austenitic steels. Prepare samples to 000 paper. Fe or Al cathode.	15
				do	do	do	do
Armco & white cast iron 3% Silicon steel						Iron cathode	13
Austenitic steels	Acetic anhydride. Perchloric acid (65%) 2 pts. to 1 pt.	6					
Iron & silicon iron	Orthophosphoric acid. Sp. Gr. 1.316	0.6	0.75 to 2.0	15 - 22	8 - 10	Stir solution if length of electrolysis is over 10 min. Polish to 000 paper. Tin cathode. Electrodes 2 cm. apart	12
Tin	Acetic anhydride—806 cc. Perchloric acid—194 cc.	9 - 15	25 - 40	Room	5	Polish to 0000 paper. Copper cathode. Electrodes 2.2 cm. apart.	7
Copper	Orthophosphoric acid—Sp. Gr. 1.3 to 1.4	0.65 - .75	2	15 - 22	10 - 15	Polish to 00000 paper. Copper cathodes	5
	Pyrophosphoric acid—530 g/l	8 - 10	1.6 - 2.0			Rough metallographic polish. Cobalt cathode	11
Cobalt	Orthophosphoric acid—Sp. Gr. 1.35		1.2	50	15	Allow 4-5 g./l. to enter solution. Polish to 000 paper.	
Aluminum	Perchloric acid—Sp. Gr. 1.48 Acetic anhydride—2 pts to 7 pts.	3 - 5	50 - 100	Room	3 - 5 15	Al cathode 0000 paper. Solution agitated by air or nitrogen.	8
Zinc	Potassium hydroxide—25% solution	16	6			Copper cathode. Electrodes 2.5 15 mm. apart.	10
Lead	Acetic acid—650 - 750 Perchloric acid—350 - 250	1 - 2				0000 paper—horizontal anode used at C.D. of 20-25 amp./dm.^{2} for 1-2 min. to remove flowed layer. Copper cathode.	5
					3 - 5	"	do
Pb-Sn Alloy	"	2		15 - 22	8 - 10	"	12
Tin + 3% Sb	"	9 - 15	25 - 40		5 - 10	Polish to 000 paper. Copper cathode. Electrodes horizontal and ½" apart.	14
Copper + 3.2% Co	Orthophosphoric acid—Sp. Gr. 1.35	0.07	2				
Copper + 2.4% Fe							5
Brass 70-30	Orthophosphoric acid—430 g./l.	13 - 15	1.9				5
Brass 66.7 - 33.3	Orthophosphoric acid—990 g./l.	2.5 - 3.0					5
2 constituent Brass 60-40	Pyrophosphoric acid—530 g./l.	9 - 11	1.9				5
Al Bronze	Orthophosphoric acid—990 g./l.	1 - 2					5
Leaded Bronze 85 Cu 10 Sn 3 Zn 2 Pb							
Phosphor bronze Silicon bronze Monel	Methyl alcohol (abs.)			20 - 30	Seconds	Cathode of Sb St cloth in bottom of dish. Distance between elect. ½ to 1 inch.	17
Nichrome Nickel Austenitic steel	Nitric acid (conc.)	40 - 50					
Copper Zinc Brass	2 pts. to 1 pt.						

mechanical polishing. The stainless steels, due to poor thermal conductivities and hardness of surface, had tendencies to overheat locally upon polishing and cause surface contamination which would result in rusting. Also due to hardness, the costs were prohibitive, and difficulties were encountered in polishing wire and other shapes. Considerable research on electrolytic polishing has brought out several baths that are giving satisfactory results.

Mason and Tosterud[25] used a 1 to 60% H_2SO_4 and 0.2 to 1.5% HF solution at 100 amperes per sq. ft., the applied voltage being between 8 and 10 volts, and a temperature of 60° C.

This was followed by Blaut and Lang[26] who used also sulfuric and hydrofluoric acids, but both this method and the preceding have the objection of the presence of HF fumes.

Other methods are now being used commercially and they are listed in Table I.

Other metals have also been polished electrolytically such as nickel, Lindh[27] reporting polishing of nickel electrolytically using a 45 to 62° Be sulfuric acid bath at 280 to 560 amperes per sq. ft., and Pullen[24] polishing aluminum using baths containing sodium carbonate and phosphate.

Although considerable success was obtained on various metals tried above, very little work apparently was done on the polishing of ordinary steels. The data obtained showed Jacquet getting a high polish by using a mixture of perchloric acid and acetic anhydride, but the use of perchloric acid is hazardous. The mixing of the perchloric acid and acetic anhydride has to be done very cautiously as there is a violent reaction. After the two are mixed, the only difficulty encountered is the disagreeable acetic fumes when allowed to overheat.

Others claim results, such as the method of Yerger and Todd,[28] using sulfuric acid and making the surface cathodic first, then anodic, followed by a final cathodic treatment, but no claims are made as to brightness of polish or surface. Uhlig[36] suggested using "carbitol"† and phosphoric acid. Uhlig stated also that ordinary steel and iron are more difficult to polish electrolytically than stainless steel.

† A glycol derivative of Carbide and Carbon Chemicals Corp., New York, N. Y.

A general summary of the work on electropolishing of metals anodically shows that highly concentrated solutions of the following acids are used for many metals.

Sulfuric acid
Phosphoric acid
Chromic acid
Sulfuric and phosphoric acids
Sulfuric and citric acids
Sulfuric and hydrofluoric acids

Lower acid concentrations produce a less brilliant finish. Current densities are high, from 1 to 12 amperes per sq. in., and voltage varies from 4 to 25 or more volts.

Scale should be removed by pickling first in order to minimize time required for polishing. The polishing time should be as short as possible due to the high energy consumption at the current densities used.

A comparison of conditions used by various experimenters is shown in Table II.

Theory

To reduce the cost of polishing metals and to obtain a more satisfactory finish for a method of treating ferrous metals, it is suggested that the procedure be altered so that instead of polishing being the final step after plating, it be one of the first steps followed by bright plating of the desired metals or finishes.

Mechanical Polishing

A surface mechanically polished does not give maximum adherence to a plated coating. This may be due to several reasons, such as:

1. Crystals on the surface are deformed and work hardened and frequently are poorly coherent.

2. Foreign matter may be occluded in the surface by the lapping of metal plates formed by polishing action. These particles may cause poor adherence or even blistering especially if object is subject to heating or temperature changes.

3. Surface cannot be polished scratch-free or any finer than fineness of abrasive used. The successive polishing with finer grades of abrasive becomes more expensive with each step and, therefore, higher polishes become prohibitive.

The difficulties in obtaining a satisfactory plating on a mechanically polished surface have been reported by Pinner[37] and by Hothersall and Hammond.[38] Phillips[39] also found that nickel offered better corrosion resistance when plated on a smooth polished surface than when plated on a surface only roughly polished. And Bower[40] reports that loose-grained polishing provided surfaces for plating that were superior in quality to those obtained by ordinary polishing procedure.

Electrolytic Polishing

In order to overcome the disadvantages of mechanical polishing and to decrease the cost per unit, electrolytic polishing is now being used for various metals, such as stainless steels, brass, nickel and copper. Steel and iron are more difficult to polish electrolytically than stainless steel, due to the higher corrosion rate in most acids and because varying heat treatment and carbon content of the steel or iron alter the conditions for producing the best results.

Since electropolishing is an outgrowth of electropickling, a comparison or study of the differences has been made. In electropickling, the conditions are so adjusted that corrosion takes place as evenly as possible, and current is kept on until film or oxide is removed from the entire surface by the removal of a thin layer of the base metal. In electropolishing, the surface is already cleaned but needs to be smoothed or polished; corrosion of the entire surface is unnecessary and not desired. In order to accomplish this, a point between corrosion and complete polarization of anode is sought, it being shown that under these conditions, theoretically, the best polish would be obtained as has been discussed by Jacquet[5] and Elmore.[13] Electrolytic polishing of metals is apparently acomplished by preferable anodic solution of high points on the surface of the metal. With conditions so adjusted as to give a partial passivity, anode corrosion products undoubtedly form a viscous, poorly conducting film of metal salts which adhere to the valleys or indentations on the surface, but expose the hills to electrolytic solution or corrosion, thus the high points are dissolved while the valleys are undisturbed. This may be illustrated as in Fig. 1.

In an electrolytic cell, the formation and reduction of ions will cause a depletion of the metal ions at the cathode and a build-up at the soluble anode, when the rate of corrosion at the

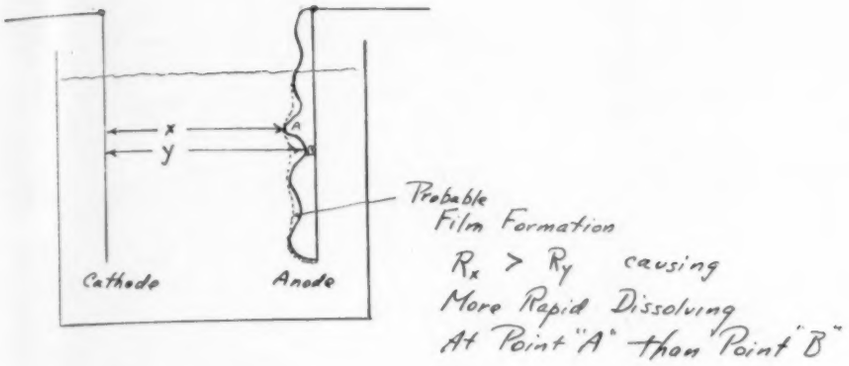

Fig. 1. Diagram of mechanism of electropolishing.

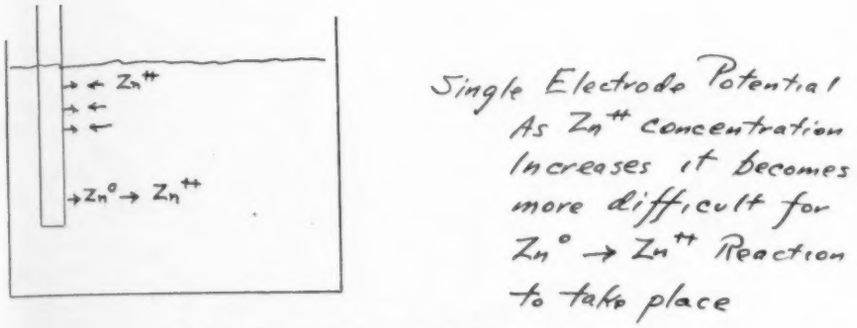

Fig. 2. Diagram illustrating single electrode potential.

anode surface is greater than the migration rate, the build-up of metal ions at the anode surface reaches a saturation point and forms an insulating film. This is proved by single electrode potentials as shown in Fig. 2. As the solution becomes more concentrated, a higher voltage is required to force metals into the ionic state and when concentration is high enough, passivity results forming an insulating film. At the high points, the film will be the thinnest and offer the least resistance. This will cause the "hills" to dissolve until they are reduced to the same height as the remainder of the surface. When the surface has been leveled, the rate of corrosion should be equal at all points and, therefore, increase in time should not affect the polish obtained. However, it is possible for the film to become disturbed either by temperature rise, by agitation or by impurities present in the metallic surfaces. This will lead to an uneven surface which would defeat the purpose of the process. It is possible in some cases, however, to polish to extreme depth. As a general rule, it is unnecessary and undesirable to apply current after a polish has been obtained. As Jacquet[2] and others have shown, eventually the metal surface is leveled to a microscopic plane showing microscopic undulations. The microscopic surface corresponds to a degree of polish equal to or better than that obtainable on a metallographic polishing wheel.

Acid radicals, such as phosphates, perchlorates, fluorides and nitrates form soluble metal complexes and compounds apparently necessary at the anode surface for the blanketing of depressions, and thus affect polishing action. Phosphates are in the category of ions essential to the polishing electrolyte apparently because metal phosphates can form the viscous film which protects from anodic attack the metal in the recesses and cavities of the surface. These ions migrating to the anode surface can be pictured as forming concentrated metal phosphates in reaction with metal undergoing electrolytic solution. The viscous metal phosphates limit the current reaching the underlying metal which they blanket, and only slowly diffuse into the main body of the electrolyte. During the slow diffusion, metal proturbances are more nearly exposed to electrolytic action and are, therefore, more rapidly attacked.

Some evidence has been accumulated by Uhlig[36] to illustrate the mechanism whereby addition of organic substances to phosphoric acid improves polishing. For instance, glycerin added to phosphoric acid aids the polishing of stainless steel. The decomposition potentials of glycerin—H_3PO_4 mixtures at 100° C. were found to be no different from that of phosphoric acid alone at the same temperature, so that electrode reactions appear identical. The current voltage data for 18—8 steel electrodes show that the conductivity of the glycerin mixture is lower, which fact probably has some bearing on its effect of improving the polishing, allowing the same saturation at anode surface or polarization to take place at a lower current density. From the data collected by Uhlig,[36] it seems that the anode film of metal phosphates can be maintained at a lower critical current density with the glycerin mixture than with the phosphoric acid alone.

Increasing the current density above a critical point does not seem to disrupt the polishing effect, but with decreasing below the critical current density, diffusion processes exceed the rate of formation of the phosphate film with consequent disruption of polishing. Another important function of glycerin or a similar organic substance is to prevent pickling action of anode by acid independent of anodic solution. In pickling, the acid attack upon a metal is along crystal boundaries. This causes the resultant surface to be roughened or etched as shown later in a photomicrograph. When the surface is polished, the metal is removed more nearly in a plane and the result is much smoother, as shown later in photomicrograph.

It is this factor of etching by localized attack which serves to increase the difficulty of electrolytically polishing steel and iron as compared with stainless steels. Tests to date have not shown any organic compound that would act satisfactorily for all steels. Addition of concentrated sulfuric acid to phosphoric acid was found to inhibit the chemical action if temperatures were not allowed to become excessive. This is probably due to the formation of complex sulfate compounds at the higher concentration and acting similar to the phosphate film discussed above.

The results using phosphoric and sulfuric acids as well as those for other tests run, are given in tabulation below under observed data.

(To be continued in June issue)

Report on Dropping Tests for Zinc and Cadmium Coatings†

Prepared by W. E. Buck[1]

EDITOR'S NOTE.—This report has been submitted to Committee A-5 on Corrosion of Iron and Steel on behalf of its Subcommittee VII on Methods of Testing. It has been recommended by the committee for publication as information. It has not been acted upon officially by the Society.

FOR the purpose of determining the apparent interest in the use of dropping tests as applied to various zinc (including hot-dipped zinc) and cadmium coatings on steel sheets, hardware, etc., the following subgroup was appointed from Subcommittee VII on Methods of Testing, of Committee A-5 on Corrosion of Iron and Steel:

W. E. Buck, chairman, Continental Steel Corp.
R. W. Baker, Republic Steel Corp.
G. Soderberg, Udylite Process Corp.
E. S. Taylerson, Carnegie Illinois Corp.
J. W. Crofoot, G. L. F. Farm Supplies
F. L. Wolf, Ohio Brass Co.

This report has been prepared summarizing the information obtained by the subgroup.

Hot-Dipped Galvanized Sheets:

So far as can be determined "dropping tests" are at present not in general use as a method of testing hot-dipped zinc-coated (galvanized) sheets. Federal Specification QQI-696a, issued as a proposed revision of the Federal Specification for Iron and Steel; Sheet, Black and Zinc-Coated (Galvanized) QQ-I-696, provides for the use of the Hull-Strausser[2] dropping test on both hot-dipped and electroplated zinc coatings on sheet steel. This specification provides for a solution of one composition for testing hot-dipped coatings and another composition for testing electroplated coatings.

Federal Specification W-O-821b, issued as a proposed revision of Federal Specification for Outlet Boxes, Steel, with Covers and Accessories W-O-821a, provides for the use of the Hull-Strausser dropping test on hot-dipped, electroplated or sherardized zinc coatings and on electroplated cadmium coatings.

Electroplated Materials:

It was reported that dropping tests are in wide use for both electrodeposited zinc coatings and cadmium coatings on forgings. castings, and stampings, but not on sheet, strip, wire, or tubing; also that several Federal Specifications at present provide for their use on the above classes of materials.

Hardware:

Dropping tests appear to be a possible method for the determination of the thickness of coatings on hardware, for which, at present, there is no satisfactory accurate method so far as the subgroup could lean. The method is not in general use in this field and the one report received was not wholly favorable.

Trends

Hot-Dipped Zinc Coatings, General:

It seems quite probable that there will be greater demand for simple field acceptance tests for hot-dipped zinc coatings. This indicates the advisability of publishing some test method for field work. The dropping test appears to offer one solution; however, its limits of accuracy should be clearly defined.

Electroplated Coatings:

All indications are that dropping tests will find continued and increasing use in this field for both zinc and cadmium electrodeposited coatings.

Limitations of Dropping Tests:

Certain shapes on account of deeply recessed or cup-shaped areas do not lend themselves to use of dropping tests.

It may require some training to distinguish accurately the end point of some compositions of coatings on certain types of ferrous base metal.

There are inherent in dropping test methods maximum errors of plus or minus 10 per cent on electroplated coatings, and plus or minus 15 per cent on hot-dipped zinc coatings, even under conditions of careful standardization.

Dropping tests are not the best available methods for

(*Concluded on page* 246)

NOTE.—DISCUSSION OF THIS REPORT IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

1. Chief Metallurgist, Sheet Division, Continental Steel Corp., Kokomo, Ind.

2. *Monthly Review,* Am. Electroplaters' Soc., Vol. 22, March, 1935, p. 9.
William Blum, P. W. C. Strausser, and Abner Brenner, "Corrosion-Protective Value of Electrodeposited Zinc and Cadmium Coatings on Steel," *Journal of Research,* Nat. Bureau Standards, Vol. 16, No. 2, p. 209 (1936), *Research Paper* 867.
A. Brenner, "Dropping Tests for Measuring the Thickness of Zinc and Cadmium Coatings on Steel," *Proceedings,* Am. Electroplaters' Soc. p. 204 (1939). *Journal of Research,* Nat. Bureau Standards, Vol. 23, September, 1939, pp. 287-403 (*Research Paper R. P.* 1240).
S. G. Clarke, *Journal,* Electrodepositors Technical Soc., Vol. 8, May, 1933, Paper 11.

† Reprinted from ASTM BULLETIN, March, 1942. Publication of American Society for Testing Materials, Philadelphia, Pa.

Copper-Oxide Rectifiers for Electroplating and Anodizing

BY L. W. BURTON

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THE introduction of any new equipment brings up problems concerning the best application and use. This is also true of copper-oxide rectifiers for electroplating. The use of copper-oxide rectifiers for industrial applications is not new since these rectifiers have been manufactured for 15 to 18 years. Early in 1920 it was found that under certain conditions the resistance of a copper oxide film on copper was greater in one direction than in the other. Further investigation revealed that it was possible to obtain a high ratio of resistance between the forward and reverse directions, resulting ultimately in the development of the copper-oxide rectifier.

The fundamental part of the rectifier consists essentially of a copper disc or plate which has been heated in a furnace to a high temperature and subsequently quenched in water. This treatment produces a thin film of cuprous or red oxide with an outer layer of cupric or black oxide. This outer layer is removed or reduced leaving the red oxide. The junction between the oxide and the mother copper has the valuable property of permitting current to easily flow from oxide to copper, but offers a high resistance to the flow in the opposite direction.

The copper-oxide rectifier originally consisted of several discs, usually 1½-inch in diameter, assembled on a bolt. Radiating fins were used to give additional cooling making possible higher ratings. Developments within the last few years have made possible the construction of rectifier plates much larger than the original 1½-inch diameter disc. In fact there is little to limit the size of the rectifier plate although economically, it is limited to a few inches on each side. The plate used in the assembly of the copper oxide stack used in the plating rectifier is about 4½-inches by 5-inches. These plates are assembled on a bolt with proper space between plates to allow free circulation of air for cooling.

Before taking up the actual installation and use of copper-oxide rectifiers for electroplating, it will probably be desirable to first discuss the description and construction.

Description

The rectifier can be divided into three essential parts: The rectifier element, the transformer and a means of adjusting or controlling the output.

The function of the rectifying section is, of course, to convert direct current output from the a.c. input. The power input is usually three phase. The d.c. output will, therefore, have the characteristic three phase ripple similar to the commutator ripple of a motor generator. With rectifiers of large capacity, it is desirable and economical to cool the rectifier units by means of forced ventilation from a fan. The fan can be mounted either as a blower or exhaust to pull the air past the elements of the rectifier. A wind relay is used to protect the rectifier elements in case of failure of the ventilating system. This relay operates by the flow of air and is connected to a contactor located in each rectifier which controls the power supply and removes power from the rectifiers in case the flow of air is interrupted to any rectifier.

The transformers are used to step down the a.c. voltage to the proper value to be supplied to the rectifiers. These transformers are located in the cooling system to take advantage of the additional ventilation from the fan.

The control of the output is obtained by a separate set of transformers which controls the voltage input to the main power transformers in the rectifier. Two sets of transformer taps are provided, one coarse and one fine. This gives satisfactory and efficient control of the output in 36 or more steps between one and six volts.

This type of control eliminates the necessity of tank rheostats with their inherent losses. The transformer adjustment of the output gives high overall efficiency over the output range.

Construction

The construction of plating rectifiers can be roughly divided into two types. In one the control with the adjustment switches, transformers and rectifiers are all

mounted in one casing. This arrangement is common for rectifiers of smaller capacities. This same construction can also be used for larger ratings. It is, however, necessary to locate the rectifier in an area adjacent to the plating tanks and convenient for the operator to make the necessary adjustments of the output.

The other type of construction uses a separate regulator. The rectifier elements, transformer and other auxiliary equipment are mounted in a separate casing. These rectifier sections can be grouped in a protected location convenient to the plating tank. The regulator is mounted separately in a location convenient for the operator to make the necessary adjustment of the output. This arrangement allows a maximum of flexibility, uses available space economically and is convenient for the operator.

Application

The use of rectifiers offers many advantages in the arranging of equipment in the plating area. A decentralized arrangement can be used and it might be compared to a machine shop using a centralized or decentralized power supply. With a centralized power supply, it is necessary to arrange equipment in a small area convenient to the motor or engine furnishing the power.

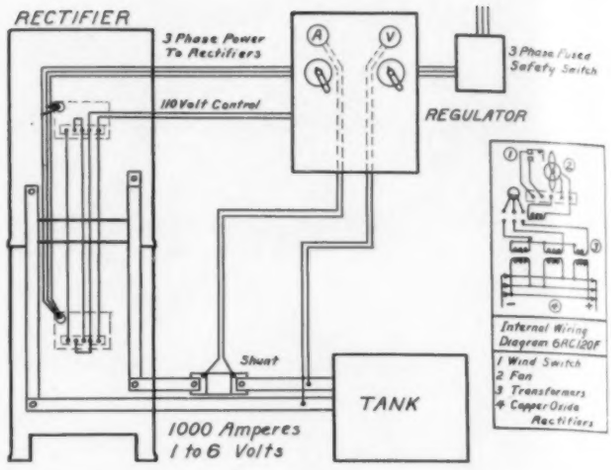
On the other hand, if a separate source of power is supplied with each piece of equipment, it is no longer necessary to group the equipment in a small area. The equipment can then be arranged in the most convenient location. This is also true of plating equipment where it may be convenient to arrange the plating tanks close to the area in which the material is fabricated. This arrangement is also desirable in central plating rooms where the tanks can be arranged in the most convenient sequence without having to consider bus bar length or losses.

A decentralized power supply is more economical. It eliminates long bus bars and tank rheostats offering a saving in both material and efficiency. Long bus bars with the associated voltage drop are eliminated. Tank rheostats are also eliminated since the output is controlled by transformer taps in the regulator.

Rectifier Connections

The unit type construction of the copper-oxide rectifier and the separate voltage regulator offer a very flexible grouping of units. The connecting of the output of the rectifiers can be compared to that of a number of storage batteries. Batteries can be connected in series when higher voltage is required, or in parallel where more capacity is needed. This is also true of rectifiers and is one of the outstanding features.

Two rectifiers and a voltage regulator are illustrated in sketch No. 1. This represents a complete installation capable of delivering 1000 amperes at from 1 to 6 volts. The three phase a.c. supply is brought in to the regulator through a standard fused safety switch. The regulator is equipped with both coarse and fine adjustment taps so that the input voltage can be adjusted before it is applied to the rectifier. If the power supply is 220 volts, the regulator will adjust this voltage to a minimum of about 35 volts which corresponds to 1 volt output from the rectifier. The full 220 volts are applied for the maximum 6 volts output.



Sketch No. 1. Showing two rectifiers and a regulator.

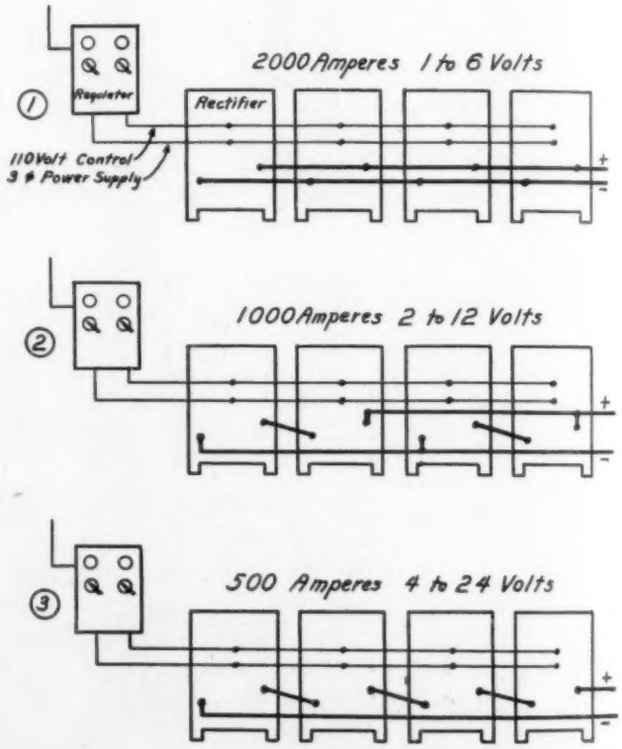


Fig. 1-3. Three possible arrangements of four 6-volt, 500-amp. units giving respectively 2000 amp., 1-6 volts; 1000 amp., 2-12 volts; 500 amp., 4-24 volts.

The power output from the regulator goes directly to the contactor in each rectifier. The power, however, cannot be applied to the transformers until the ventilating fan is up to speed and the wind switch closed. This power is supplied from a separate 110 volt transformer in the regulator. As soon as the wind switch closes, the power from the control circuit closes the contactor and power is delivered to the transformers and copper oxide units. An ammeter and voltmeter are conveniently located above the adjusting handles on the regulator.

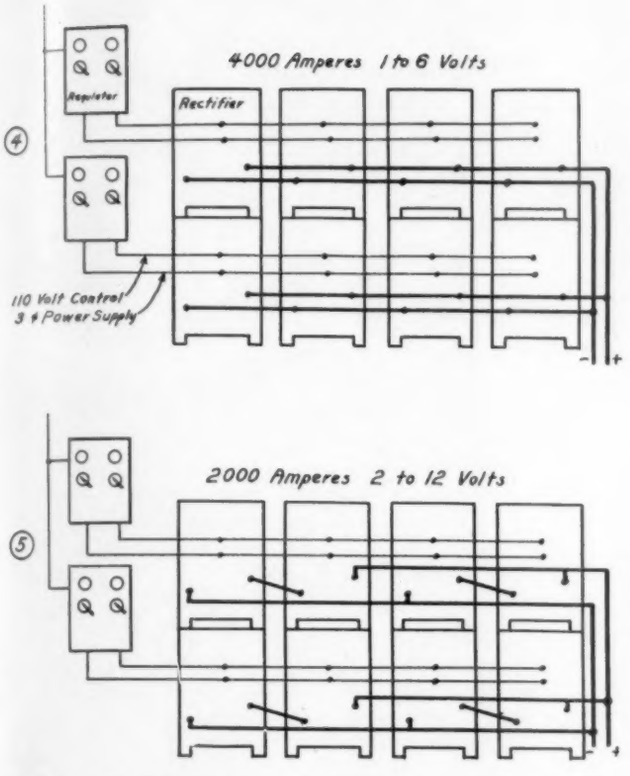


Fig. 4-5. Showing arrangement of eight units in parallel to give 4000 amp., 1-6 volts (4) and series parallel arrangement to give 2000 amp., 2-12 volts.

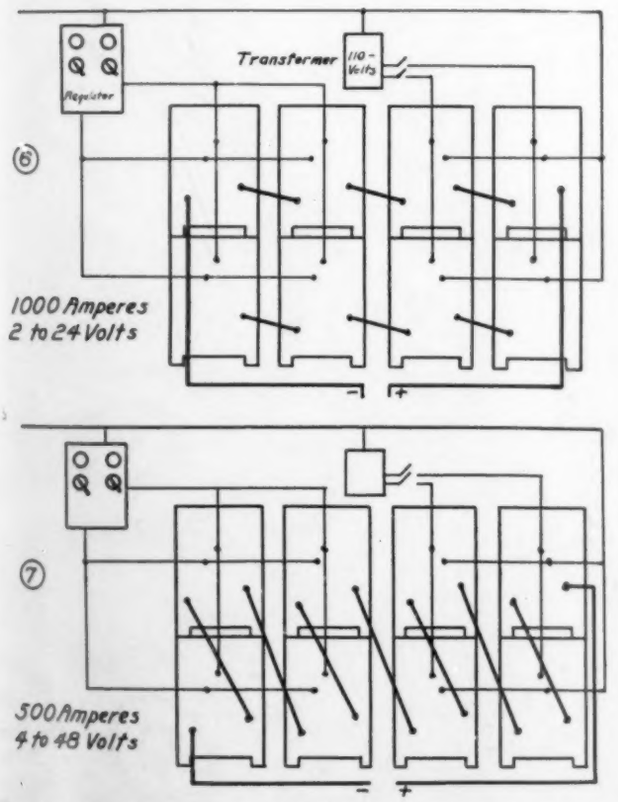


Fig. 6-7. Arrangements to give higher voltages. Fig. 6 is for delivering 1000 amp. at 2-24 volts, and Fig. 7, 500 amp. at 4-48 volts. Fig. 7 is a power set-up for chromic anodizing of aluminum.

The rectifiers illustrated in sketch No. 1 are connected in parallel with each rectifier having a rating of 500 amperes and 6 volts. These two rectifiers could also be connected with the d.c. output in series to give 12 volts, 500 amperes. The control and three phase power circuits would remain the same with only the d.c. bus being changed.

Other rectifier connections are illustrated in figures 1 to 9. The diagrams are simplified as much as possible with a single line illustrating the three phase power supply and another single line for the control circuit.

The flexibility of a rectifier installation is well illustrated in figures 1 to 3. This represents the possible connections for one regulator and four rectifiers. In figure No. 1, the units are all connected in parallel to give 2000 amperes adjustable from 1 to 6 volts. With a few minor changes in bus connections, the units can be reconnected in series-parallel to give 1000 amperes at 12 volts. Still another arrangement is possible and is quite often used for anodizing. This connects all the rectifiers in series to give 500 amperes at 4 to 24 volts, illustrated in Figure No. 3.

Figures 4 and 5 will be recognized as two groups of rectifiers and regulator as shown in figures 1 or 2, connected in parallel. Each bank can be operated separately or the current divided between the two groups to give twice the output of the single group. This same arrangement can be carried still further by connecting three or more such groups in parallel to obtain higher current rating.

For some types of anodizing, an output of 24 volts is required. Figure 3 will furnish 500 amperes. If higher current is required, four more rectifiers could be connected to give 1000 amperes. The control of these rectifiers can be modified so that only one regulator will be required as illustrated in figure 6. In operation, the regulator is turned on giving control of the output from 2 to 12 volts. As additional voltage is required, two more rectifiers are turned on giving a step of 6 volts increase at 1000 amperes. The other group of 6 volts when turned on will give 24 volts total and the regulator can be used to give final adjustment. A separate source of 110 volts will be required for the control of the rectifiers not connected to the regulator. This power can be from a separate transformer or a 110 volt light circuit. Normally all the fans would operate from this separate source of power.

The same control and number of rectifiers can also be reconnected with all eight units in series to give 500 amperes at a maximum of 48 volts. This arrangement is illustrated in figure No. 7.

In some anodizing processes, 40 volts are required. This can very easily be obtained by connecting seven units in series. Two rectifiers are connected to a regulator to control the output from 2 to 12 volts. Additional voltage is obtained in steps of 6 volts by turning on one rectifier at a time. The control for the last five units is obtained from a separate 110 volt transformer or a lighting circuit. Here again all the fans would be operated from this separate source of 110 volt power. A small snap switch in each of the control circuits could be mounted adjacent to or on the voltage regulator. The illustration of this connection is shown on sketch No. 8.

Where higher current is required at 40 volts, a circuit such as is shown in figure 9 can be used. This is very similar to that shown on sketch No. 8 except another group

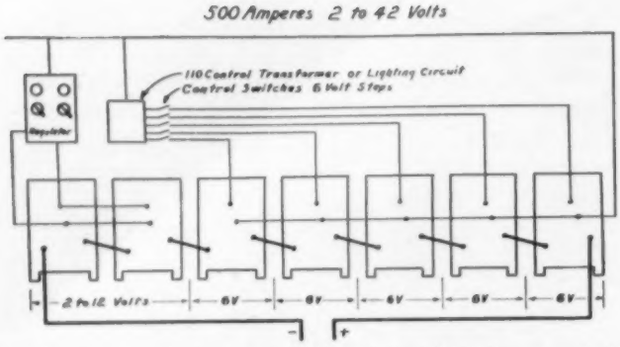


Fig. 8. Diagram showing arrangement of control switches of unit for chromic acid anodizing.

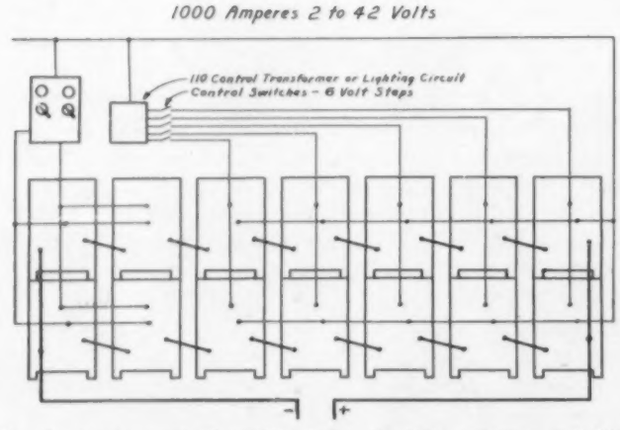


Fig. 9. Arrangement of rectifier units for high amperage and high voltage.

is added in parallel to give a total of 1000 amperes. Similar arrangements could be used if higher outputs are required.

Conclusion

The sketches illustrate one of the important features of copper-oxide rectifiers for electroplating. This is the flexibility which can be obtained. This flexibility is particularly important during the present emergency where it is necessary to do a variety of plating work. It is particularly important where anodizing equipment is used. These rectifiers which are connected in series to give from 24 to 48 or 50 volts can very easily be regrouped and reconnected for standard 6 or 12 volt plating applications.

The unit type construction where a number of rectifiers are grouped together allows economical production on a quantity basis. Because of the standard design, very prompt shipments can be made.

Another feature is that more units can be added easily if it is necessary to increase the capacity of a particular unit or tank. Sometimes it is advisable to order a regulator of a capacity larger than is actually required at the time. Additional rectifiers can then be added if it is necessary to increase the capacity.

Copper-oxide rectifiers are economical to operate and easy to install. No special foundation is required and they can easily be mounted one above the other to conserve floor space. Maintenance is at a minimum since the only moving part is the slow speed ball bearing fan. This may require inspection and lubrication once or twice a year.

Report on Dropping Tests for Zinc and Cadmium Coatings

(*Concluded from page 242*)

shop control in the production of hot-dipped zinc coatings on sheets, strip, wire, or tubing, and are therefore not in common use for production control.

Consideration of these limitations indicates the tolerances that should be allowed in specifications subject to field test by dropping test methods.

Dropping Test Solutions:

The S. G. Clarke solution of iodine in potassium iodide seems to have become obsolete. The Hull-Strausser solutions of acidified ammonium nitrate, while permitting a somewhat easier observation of the end point than the Brenner solution described later, have the drawback that their rate of reaction is influenced by the physical characteristics of the coating, making it necessary to use different solutions for different types of coating. This fact is recognized in the Federal Specifications mentioned previously.

The Brenner solution of chromic and sulfuric acids gives a reaction practically independent of the composition or physical characteristics found in either hot-dipped or electrodeposited zinc coatings and electrodeposited cadmium, with respect to rate of penetration, and is to be preferred.

Magnetic and Other Tests:

In the scope of work outlined, magnetic testing methods, electrolytic, micro measurements, and the chord methods also used for determining the thickness of metallic coatings were not included.

The magnetic method was discussed and some facts were brought out that the subgroup feels should be presented. So far as could be learned, the magnetic method is not at present being used extensively on hot-dipped zinc coatings, but several producers of galvanized products are experimenting with it. It is being used extensively to test the quality of electrodeposited coatings. The tendency at present is to use this method as an acceptance test, but not for rejection until the results are confirmed by other methods of testing.

The magnetic test method has the following limitations:

1. Requires smooth base and coating, cannot be used in small, deep recesses where the area is small enough to cause magnetic interference from the base metal surrounding the magnet at the sides.
2. Cannot be used on very small articles, unless specially calibrated, and
3. Requires carefully calibrated standards and magnets for different coating thicknesses.

The advantages of the magnetic method are as follows:

1. It is a non-destructive test, and
2. The apparatus is fully portable and requires no auxiliary or accessory equipment.

Due to the fact that there is a real demand for a method of field testing of zinc-coated and cadmium-coated products, and that such methods are being incorporated in specifications by some specification writers, it would appear to be desirable for the committee to investigate thoroughly the limitations of the various methods of field testing.

Aircraft Electroplating†

BY R. R. JANSSEN

Process Engineer
North American Aviation, Inc.

ELECTROPLATING is as essential to the airplane as the very rivets from which it is made. In fact even those rivets are electroplated by anodizing for protection against corrosive attack. This corrosion prevention is the most important reason for electroplating on an airframe. The motor, which combines with the airframe to make an airplane, will not be discussed here, but has been thoroughly covered in the March, 1941 issue of the Monthly Review of the American Electroplaters' Society. The three principal uses of electroplating on an airframe then are: (1) to provide corrosion prevention, (2) to provide a smooth, hard bearing surface, (3) to provide a means of masking for selective hardening of steel parts.

The principal methods for plating to obtain corrosion prevention are anodizing for aluminum and cadmium plating for steel, brass, or bronze. Those used more rarely are tin and zinc plating. In the manufacture of airframes, chromium plating is the principal method used to obtain bearing surfaces which are smooth and hard. Other types of plating, such as indium, have found some use in motor manufacture but as yet have not been found adaptable to airframe construction. Copper is the material used for masking prior to selective carburizing. These treatments will be discussed in detail here with their special application in aircraft.

Anodizing

Anodizing, used almost exclusively on aluminum, is undoubtedly the most important single form of plating used in aircraft construction. This process consists of forming aluminum oxide on the surface of aluminum alloys, by electrochemical means, as a very thin but impervious film of aluminum oxide. This film prevents the further oxidation of the aluminum and forms an excellent base for paint.

It is interesting to note that anodizing represents practically 100% throwing power. This is explained by the fact that aluminum oxide is not a good electrical conductor. Consequently, when the corners get anodized first they no longer are conductive. Those parts not yet affected still conduct current and hence will get anodized. This goes on until all areas are anodized.

It is the statement of some that anodizing is not an electroplating operation but this idea is based on the definition of electroplating as the electrodeposition of a metal. However, the American Standards Association defines electroplating as "the process of depositing, by means of an electric current, any metal or other substance on a given object or objects." Since in this case, oxygen is deposited on the surface where it combines with the aluminum, anodizing can be interpreted as being an electroplating process.

The electrolyte used in anodic oxidation consists of 5% by weight solution of chromic acid in tap water. It is necessary, however, to limit the amount of chlorides and sulphates in order to obtain a good anodic coat. The bath is operated at 95° F. and is controlled within ±4° F. Many organizations have varied these figures and claim better results. However, the above procedure is standard and has been shown to give satisfactory and reliable coatings. The voltage used, is, unfortunately, 40 volts instead of the standard plating voltages. Normal current densities are of the order of 1½ to 2 amp./sq.ft. Thirty minutes is the standard time for the anodizing treatment. These are the highlights of anodizing by the chromic acid method. Sulphuric acid is also used as an electrolyte in the commercial process of "alumiliting." * This process is limited in use due to the fact that it is a patented process and that it is not allowed by Army-Navy specifications on completed assemblies[1] but it may be used on detail parts. Alumiliting is used extensively in commercial practice as a method of coloring aluminum alloys.

Cleaning Before Anodizing

Anodizing does not require the high standard of cleaning that most electroplating processes demand. However, parts which are excessively oily or greasy are usually cleaned in an alkaline cleaner especially designed for cleaning aluminum. Ordinary plating cleaners cannot be used on aluminum because of their tendency toward etching. Consequently milder cleaners must be used. Occasionally precleaners of the solvent type are used to prevent excessive contamination of alkaline cleaning bath. This is usually not warranted, however, due to the low cost of cleaners of the alkaline type.

Anodizing Substitutions

In recent years, other processes for treating aluminum have been used such as "chromadizing" and the "Alrok"* process. Alclad consists of a high strength aluminum alloy sandwiched between two layers of commercially pure aluminum. These outside layers, each about 5% of the total thickness of the sheet, protect the stronger alloy electrochemically. Chromadizing (or chromatizing) is essentially

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† Presented at Annual Educational Session of Los Angeles Branch, American Electroplaters' Society held at Los Angeles, Cal., Mar. 21, 1942.

* Trade-mark registered U. S. Patent Office by Aluminum Company of America. 1.– Which are subject to stress and which contain joints or recesses in which the anodizing solution may be retained.

anodizing without electric current with the exception that a higher temperature (140° F.) and a shorter time (5 minutes) are used. Parts must be considerably cleaner when they are to be chromatized than if they are to be anodized. However, the same type of cleaner is used. Chromatizing, while forming a good base for paint, is of little value when not painted. Chromatizing, like most substitutes, is not as good as anodizing but on land-based airplanes is usually adequate and it represents a considerably cheaper and quicker method where the demands are not too critical. The "Alrok" process consists of an oxidation process giving results similar to chromatizing. The procedure involves immersion in a near boiling solution of sodium carbonate and potassium dichromate for a period of 30 minutes followed by a sealing treatment in a hot 5% potassium dichromate solution. "Alrok" is a patented process and has not found any great acceptance in aircraft work.

Inspection of Anodized Coatings

An anodized coat, when obtained by the chromic acid process, is a grey color and shows the grain structure of the base metal. It is non-conductive to electricity which provides a quick method for determining whether or not a part has been anodized by making an electrical conductivity check using an ordinary light bulb in series with the aluminum alloy under test and the source of electric light power.

To determine whether a satisfactory coating has been applied, the standard test is a 20% salt spray solution operating at 95° F. for 250 hours. For the material to be satisfactory it must not show more than a 5% reduction in tensile strength or a 10% reduction in elongation at the end of this period.

Inspection by Anodizing

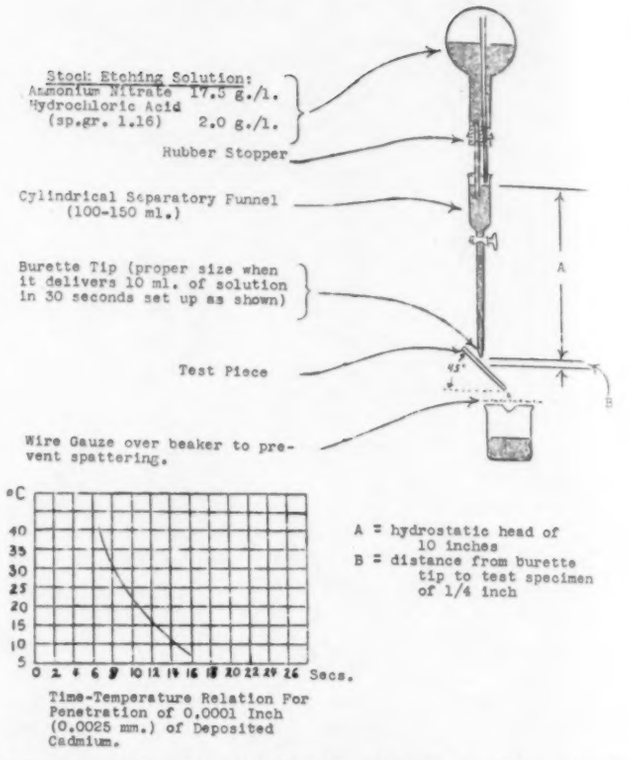
The ability of anodizing to accentuate cracks in the base metal is used as a method for the inspection of aluminum forgings. A large amount of work has been done to find a simpler and easier method, and while some of these have been adopted, none seems to work quite as well as anodizing. This is largely due to the fact that the chromic acid solution tends to permeate into the crack. When the part is subsequently ground to remove this crack it is possible to see the indication until it has been completely removed. This is a great advantage since otherwise the part would have to be retreated at least once during the grinding operation in order to be certain that all cracks were completely ground out.

Size of Parts

Parts to be anodized may vary from very small detail parts to very large sub-assemblies. Normally aircraft anodizing tanks vary from 20 to 35 feet long and are 5 to 6 feet deep with a width of 3 to 5 feet.

Cadmium Plating

Steel is protected almost universally in aircraft construction by means of cadmium plating. Cadmium was chosen after many tests had been run to determine the material most satisfactory for corrosion resistance. There has been much discussion from time to time as to the relative protective powers of cadmium and zinc plate. Cadmium was found to have a higher resistance to corrosion by salt


Stock Etching Solution:
Ammonium Nitrate 17.5 g./l.
Hydrochloric Acid (sp.gr. 1.16) 2.0 g./l.
Rubber Stopper
Cylindrical Separatory Funnel (100-150 ml.)
Burette Tip (proper size when it delivers 10 ml. of solution in 30 seconds set up as shown)
Test Piece
Wire Gauze over beaker to prevent spattering.
A
B
45°
°C
40
35
30
25
20
15
10
5
0 2 4 6 8 10 12 14 16 18 20 22 24 26 Secs.
Time-Temperature Relation For Penetration of 0.0001 Inch (0.0025 mm.) of Deposited Cadmium.
A = hydrostatic head of 10 inches
B = distance from burette tip to test specimen of 1/4 inch

Apparatus and data for determining the thickness of cadmium plate by means of a drop test.

water spray than zinc coatings could provide. This is largely due to the fact that zinc chloride forms very readily from the bare zinc. In other atmospheres zinc has often been found superior to cadmium, probably for the reason that zinc will provide electrolytic protection over a larger area. One very neat method for showing this is to take two ordinary steel washers and put into the hole of one, a zinc plug, and into the hole of the other put a cadmium plug. Under normal conditions it will be found that both the cadmium and the zinc will corrode away leaving the steel relatively unaffected. Now, if the size of the washer is increased until the edges are no longer protected by the plug, it will be found that zinc will protect a larger washer than will cadmium. The principal advantage of cadmium is that it forms a relatively impervious coating which is not much subject to atmospheric attack whereas the zinc is quite active and tends to corrode away, particularly in seashore exposures, finally leaving the base metal unprotected. Cadmium is applied in the aircraft industry in a standard cyanide bath. Since this is a standard procedure I will not go into the details of the bath or plating procedure.

Commercial practice has shown that coatings of 4 to 5 ten thousandths of an inch are the most economical for outside exposure. Both the Army and Navy specify the lower limit of 5 ten thousandths for all parts inside or outside the airplane except for externally threaded parts for which two ten thousandths is specified, since under-cutting of threads is not allowed. Normal procedure for testing the thickness of the plate is by the drop test. (See attached illustration.) In this test the solution is allowed to drip onto the part at a specified rate and at a specified angle. By timing the period it takes for the test solution to eat through the plate the thickness can be determined. This test provides

a quick and relatively accurate method for determining the thickness because a two ten thousandths inch plate will be eaten away in twenty seconds, each second representing one one hundred thousandth of an inch. The objections to this method are two-fold—first, it destroys the plate and second, the end point is somewhat difficult to determine. The only important cause for rejection of cadmium plated parts is on the basis of inadequate thickness of plate. Each batch of material is checked for thickness, by the drop test previously mentioned, upon arrival at the aircraft manufacturer's plant so that it behooves the sub-contractor to make sure of his plating thickness before submitting his parts to the purchaser.

Army-Navy specifications require that no undercoating of any kind be used before cadmium plating. This is usually well understood by the plater and does not provide more than an isolated case of trouble. Occasional cases have recently been found where the copper plate used for selective casehardening was not removed before cadmium plating. This was discovered when the parts began to corrode. It is important therefore that no undercoats be used.

Ordinarily steel fittings of relatively small size constitute most of the cadmium plating requirements although some welded assemblies, including entire fuselage frames, are cadmium plated by some manufacturers. Tanks are usually 6 to 8 feet long*. Of course for larger welded assemblies larger tanks must be used.

* 4 to 5 feet deep.

Hard Chromium Plating

Chromium plating is much more of a problem than is cadmium. In this case thickness of plate is relatively inconsequential since it is not applied for the purpose of corrosion prevention but for the purpose of obtaining a hard smooth surface. Practically 100% of all aircraft chrome plating is "hard" rather than "decorative" chromium plate. In general chromium plating done outside of the aircraft plant has not been satisfactory for two reasons—(1) misunderstanding of plating problems by the aircraft designer and those responsible for preparing the base part for the plater; (2) by lack of understanding on the part of the plater for the rigid requirements demanded by airplane hydraulic parts. Critical aircraft hydraulic parts in general consist of a cylinder with a chrome plated operating piston and piston rod. The hydraulic fluid is prevented from leaking around the piston by means of rubber or synthetic rubber packings. Now these packings have a disgustingly short life particularly if the piston which rubs back and forth across these rubber packings is in the least bit rough. The rubber packings have to hold in pressures varying from 750 psi to a ton and a half per square inch. With these pressures, the packing is forced very tightly against the piston rod in order to prevent leakage. This means that any slight irregularity in the piston, going back and forth over the surface of the packing, will result in excessive wear to the packing. This condition requires frequent replacement of packing and constitutes a serious hazard as many critical controls in the airplane, such as wingflaps and retractable landing gears are hydraulically operated. The need immediately becomes apparent for having a perfectly smooth plating job with no variation in diameter from spot to spot along the piston. Now all this makes it rather hard on the plater because the raw parts coming to him from the aircraft manufacturer will probably *not* be ready for plate. This condition is something which the industry has been trying to improve.

Before Plating

Nearly all hydraulic pistons are centerless ground before being delivered to the plater. Often the wheel used will be quite coarse and the machining marks are quite apparent, especially after plating. Consequently, a large amount of polishing is necessary before plating takes place. These hydraulic parts, by the way, are usually "size" plating jobs. The general procedure in preparation is to use an abrasive wheel to take out the machining marks. Frequently it is advisable to use a 180 wheel followed by a 220 wheel. This is usually followed by a sewed buff using a cutting compound and then by a loose buff to give a high color. It is not anticipated that the aircraft company will ever provide the parts in such good condition that the last two steps can be avoided. By proper selection of centerless grinding wheels however, the use of the abrasive wheels can be eliminated. Often parts may come to the plater with nicks which were caused by rough handling. If the nicks are not deep they may be taken out. However, since everything is done by the airplane designer to reduce weight, often these parts may be stressed to the legal limit. Therefore before removing deep nicks, the plater should get the approval of the aircraft manufacturer. Part drawings give the lower dimensional limits before plating. These should not be exceeded in removing nicks. Unless approval to remove the nicks can be obtained, such parts should be rejected by the plater. A good test for determining whether a part is sufficiently smooth for plating is to run your fingernail along it. In this way very minute scratches can be detected. If you can feel these scratches the part is not smooth enough. So much for the preparation of the part for plating.

Plating Procedure

Hard chrome plating as done in aircraft usually uses a standard 33 oz. per gallon solution of chromic acid with a chromic acid sulphuric acid ratio of 100:1. Of course, being hard chrome plate, no undercoats are allowed. Normal thickness of plate runs from 15 ten thousandths to 20 ten thousandths per surface or 3 to 4 thousandths on the diameter. For special applications this might run up as high as 7 thousandths. The actual thickness of plate depends on whether the unplated part is on the high or the low side of its tolerance. Aircraft drawings specify the size before and after plating rather than specifying the thickness directly. Ordinary plating tolerances are of the order of ± 1 thousandth on the diameter of the part. Special applications of course require much closer tolerance. Details of bath and actual plating procedure will not be discussed because, again, they are standard.

(*Concluded on page* 251)

Planning Rectifier Installations†

BY LOUIS W. REINKEN

W. Green Electric Co., New York

IT IS essential, particularly at this time, that any new equipments, such as rectifier units, should be selected not only for immediate utilization but also to provide, if possible, a margin of flexibility to fit future new processes and changes in production cycles.

In the 1941 Guidebook (page 85), a brief description was given of several types of rectifier equipment. These equipments are now so widely used that the description will not be repeated. Assuming that the reader is generally familiar with rectifier equipment, the following notes are intended to assist him in the preliminary planning of new or revised layouts using rectifier power supplies. The rectifier manufacturer, or his distributor, can usually be of great assistance in such planning but a consideration of the following factors will be a useful preliminary.

Electrical Data

Input Power Supply—With few exceptions, all rectifier equipments for electroplating, anodizing, etc., are designed for operation with 3 phase 60 cycle power supply. Most manufacturers have standard units for 220 and 440 volts, and some build units also for 208, 260, 380, 550 and other special voltages, and also for 25 and 50 cycles.

It is worth while to determine your actual line voltage. It is not unusual to find that a "220 volt" line measures as high as 240 volts or as low as 208 volts. Specifying the exact line voltage will enable the rectifier manufacturer to supply you with a unit which will give you the full output voltage without fear of overloading the equipment.

If a choice of 220 or 440 volts is available in the plant, then 440 volts should be selected since for the same size unit the input wiring will be lighter and more economical to install.

Output Voltage—Most rectifier manufacturers have standard units for 6 volts and 12 volts. For higher voltages, for example, 24 volts or 48 volts for anodizing, these 6 or 12 volt units may be connected in series with the important advantage that they can be utilized in the future as low voltage units for ordinary cleaning or plating work. Some manufacturers also build rectifier units with maximum output voltages of 18, 24, 36, 48 and 60 volts complete in one cabinet, designed particularly for anodizing.

Before specifying the required maximum output voltage, make certain that you do not ask for a higher voltage than is actually needed. In many cases a 7 or 7.5 volt unit has been requested when further investigation has shown that 6 volts would be sufficient. This effects a considerable saving since if more than 6 volts are specified, the only alternative is a 12 volt unit.

Most standard rectifier units are equipped with voltage controls providing an ample range of control without the need for additional tank rheostats. Some 6 volt rectifier units have a range of 3-6 volts but others cover the range from 1-6 volts, or in special cases, 0-6 volts. Therefore, if you are particularly interested in low voltages, make certain that this is specified. On the other hand, if it is definitely established that only the higher voltages, for example, 4-6 volts will be required, this should be specified, particularly to manufacturers of custom-built rectifiers who can take advantage of this to supply finer voltage control over the more limited range.

Output Current—It is strongly recommended that when purchasing rectifier equipments, the specified output current should not be exactly equal to the estimated load. Although it is possible to add additional rectifier units at a later date, it is generally more economical to provide the additional current capacity in the first unit or group of units. Furthermore, it is a fact that rectifier units operated below their maximum capacity, even at as low as 30-50% of their rating, are more efficient and consume less current than smaller units operated at full capacity. Under no circumstances should you plan to operate rectifier units continuously at their full rated *overload* capacity. Although well-constructed rectifiers with a guaranteed overload capacity can be operated at the overload rating, this eliminates any reserve whatever for future possible peak loads.

Physical Layout

Rectifier equipments are of two types, those in which all the control equipment, including starting gear, voltage controls, meters, etc. are incorporated in the one cabinet and those in which the rectifier forms one or more units and the control equipment forms a separate unit. In either case, rectifier equipments are comparatively economical of floor space. However, this should not be taken to mean that a plant layout can be based on the tanks alone with the assumption that the rectifier equipment can be squeezed in any available corner. A proper plant layout will take into account such factors as accessibility of controls, visibility of meters, provision for expansion, and ventilation.

Rectifier Groups

One of the most important features offered by rectifier installations is the possibility of providing individual units for each tank or group of identical tanks. These advan-

† Reprinted from "Plating and Finishing Guidebook", 1942 Edition published by Metal Industry Publishing Co., New York.

tages have been discussed at length in articles appearing in "Metal Finishing" and in discussions at group meetings, and there is, therefore, no need to repeat them again. Briefly, the advantages derive from short bus bar runs, independent voltage and current control over each tank, elimination of tank rheostat losses and flexibility in shifting rectifier units around the plant as required.

However, if your processes are such that it is possible to supply all or nearly all of your total tank load at the same voltage, then it may be possible to effect economies in first cost by selecting rectifier units of high current capacity, or by installing groups of rectifiers connected in parallel.

If the purchase of a number of rectifier units is planned, it should be borne in mind that maximum flexibility and interchangeability are secured when all the rectifier units are identical in voltage and current rating.

The great increase in anodizing has resulted in the development of a very useful type of rectifier grouping, consisting of a number of 6 or 12 volt units connected in series. At any time these same units are available individually or in parallel for ordinary low voltage electroplating.

Rectifier Location

The better types of rectifiers are notably free from trouble and require little, if any, maintenance. Their life can be extended almost indefinitely if care is taken in selecting the installation site. There are two important factors—corrosion and heat.

Most rectifier equipments are so built that the exposed metal surfaces subject to corrosion are reduced to the absolute minimum. However, there are some parts such as contactor points and switch points which, for obvious reasons, cannot be so protected. Usually these electrical contacts are made of alloys or metals which are corrosion resisting. Nevertheless, it is not desirable to expose any piece of electrical equipment to a continuous bath of highly corrosive vapors. Rectifier equipments may be located in the plating room and reasonably near the plating tanks, assuming that ordinary precautions, such as efficient tank ventilation, are taken. As a general rule, it may be assumed that well built rectifiers will function satisfactorily in any atmosphere which is suitable for the plating operators.

Some rectifier users prefer to locate their rectifier equipment in a separate room apart from the plating room, which eliminates the corrosion problem entirely. This is desirable but not absolutely necessary. However, there are other factors which make a separate room or section desirable and these will be discussed below.

In all rectifier equipments, the most important factor limiting the output or overload capacity is heat. A rectifier operating in a normal room temperature will have a greater current capacity than a similar unit which is forced to operate in abnormally high temperatures. Most rectifier equipments are so designed that they can deliver their full rated capacity when the air supplied to the rectifiers does not exceed 95° F. This means that a rectifier equipment should be so located that it is not adjacent to steam pipes, room heating units, boiling tanks, etc. Neither should it be located in a small enclosed chamber so that its own exhaust is drawn back into the rectifier by its "cooling" fan. Under these circumstances, the rectifier temperature will obviously continue to rise.

Although it is not necessary to provide expensive inlet and outlet air ducts, it is possible in some cases to so locate the rectifiers that a window or ventilation grille provides a source of fresh air for the rectifiers. This not only ensures that the unit may be run at maximum capacity continuously, but minimizes the possibility of corrosion.

Life Expectancy

It is not possible to make a blanket statement regarding the life of all types of rectifier equipments. However, it can be said that well constructed rectifier units, intelligently located, will last indefinitely.

Aircraft Electroplating

(*Concluded from page* 249)

After Plating

Usually engineers will put on drawings simply "polish" or "light buff." Actually what they mean in almost all cases is polish, buff, and then give a high color. This source of confusion is being corrected by an educational program for the engineers. We are trying to standardize for all future drawings on "buff and color" for very smooth parts such as the hydraulic ones previously mentioned. The fingernail test applies to smoothness after plating also.

Aircraft parts to be chromium plated are usually cylinders which are plated on the outside only. The diameter of these tubes normally ranges from a fraction of an inch to two or three inches in diameter and may be as long as six feet.

Selective Casehardening

Often it is desirable to have a part which provides a hard wearing surface over only part of the material while the remainder is kept soft for increased toughness. This may be accomplished by "selective hardening" the surface by carburizing or similar means. The "stop-off" for this purpose is a good dense copper plate a few thousandths thick. This copper plate prevents the carbon from penetrating the surface of the steel at the plated areas and thereby keeping them soft. This method is in general use in industry including phases outside of aircraft.

Other Forms of Plating

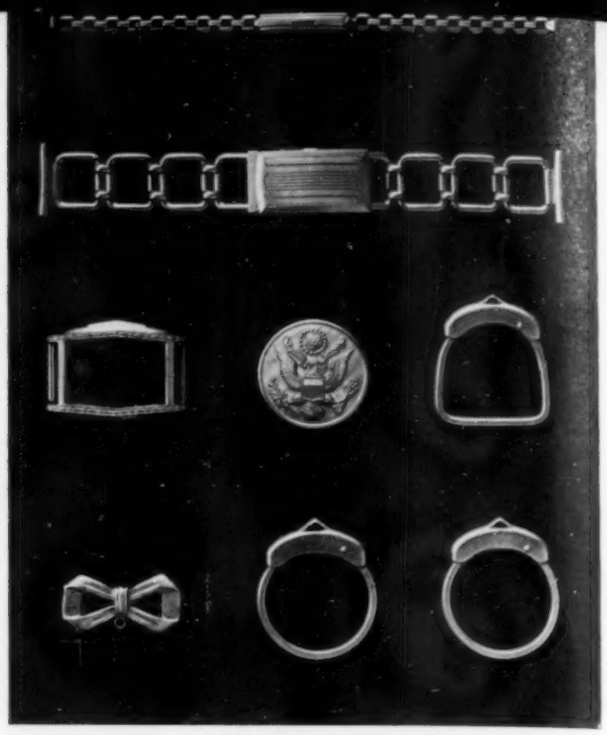
Tin is used to a limited extent in the protection of steel rivets. Its principal advantage in that usage is its great flexibility which allows the rivet to be driven without destroying the plate.

Zinc plating has not been used to any extent as yet in airframe construction but during these war conditions, its use will probably increase due to the difficulty in obtaining cadmium. The fact that zinc plating is relatively cheap speaks also in its favor.

Platinum Plating

A Substitute for Rhodium Plate

BY DR. C. B. F. YOUNG[1] & J. F. DAVIS[2]



Photograph of various articles of different base metals that have been platinum plated. The large watch strap is platinum on brass; the chain and snap is platinum on yellow gold, the bow pin, platinum on steel; the key ring, platinum on silver. The key ring in the lower right corner is rhodium on brass, and notice that the color is indistinguishable from the color of the platinum plated ring on its left.

IN A recent order, M-95, issued March 11, 1942, the use of rhodium for plating was forbidden. This order provides for restrictions on the sale or transfer of rhodium salts or solutions. Users are allowed to consume the stocks which were on hand March 11, 1942 in any manner they desire. However, when these stocks are depleted, rhodium plating for jewelry will cease.

Everyone connected with the jewelry trade knows just how serious this situation would be in normal times, but at present it is even worse due to the fact that many manufacturers are starting to use sterling silver as a base metal or are using a heavy silver plate as a protective coating. Silver must be protected from the atmosphere or it will tarnish. This can be done by applying a thin clear lacquer film but this is unsatisfactory in many instances. Another method consists of applying a thin coating of a precious metal. As stated above, rhodium has been used heretofore. What can be used in its place? If we look at a portion of the periodic system shown in Table I it will be seen that the following white precious metals remain: ruthenium, palladium, osmium, iridium, and platinum. Iridium must be eliminated as it is on priority. Osmium is not produced in any large quantity and the cost of the material is high. Palladium can be obtained but the electrolytic coatings produced to date are not too attractive due to the dark color. By process of elimination there is one metal left—platinum. At the present time the material can be purchased at a reasonable price on the open market. From the latest data obtainable at the time of writing, this condition will not be seriously altered. Perhaps this metal can be substituted for rhodium.

TABLE I

Series	*Group VIII*
4	Fe Co Ni
6	Ru Rh Pd
10	Os Ir Pt

It might be well to compare the properties of rhodium and platinum. In Table II such a comparison is given.

The electrochemical equivalents of the two are given in Table III. From the above it will be seen that per ampere hour there is roughly twice as much platinum plated as rhodium. Data for platinum having a valence of four only is given as this form is used in nearly all types of solutions.

Platinum can be plated from several types of solutions. These have been given by K. Schumpelt.[3] The oldest known bath is a phosphate type and is

TABLE II

Element	*At. Wt.*	*At. No.*	*M.P.°C.*	*Sp.Gr.*	*Valence*	*Description*
Rh	102.91	45	1990	12.5	3	Silver white metallic element.
Pt	195.23	78	1775	21.45	2 or 4	A tin white element of metallic lustre. Does not oxidize in the atmosphere at any temperature.

TABLE III

Element	*Valence*	*Mg./Coul.*	*Coul./mg.*	*Gm./amp. hr.*	*Amp. hr./gm.*	*Dwt./-amp./hr.*	*Amp. hr./dwt.*
Pt	4	0.5058	1.9772	1.8208	0.5492	1.1708	0.8541
Rh	4	0.2666	3.7509	0.9598	1.0419	0.6171	1.6204

1. Consultant, A. Robinson & Son.
2. Sales Engineer, A. Robinson & Son.
3. Plating and Finishing Guidebook, pp. 58-59, 1941.

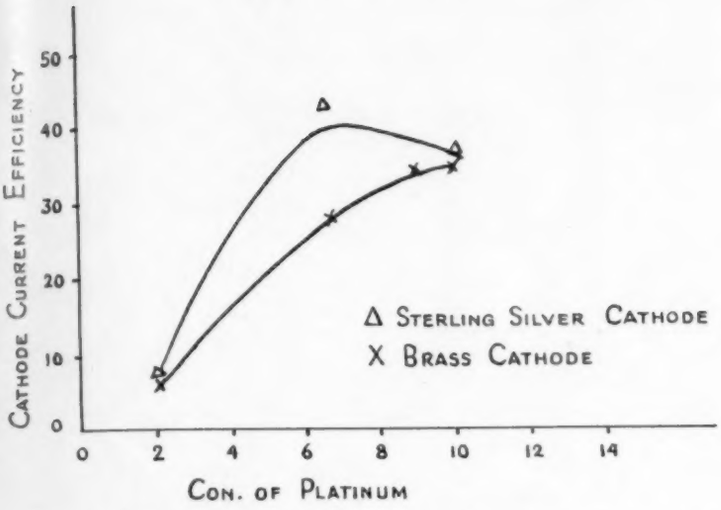


Fig. 1. Relationship between cathode current efficiency and concentration of platinum in solution on two types of cathode.

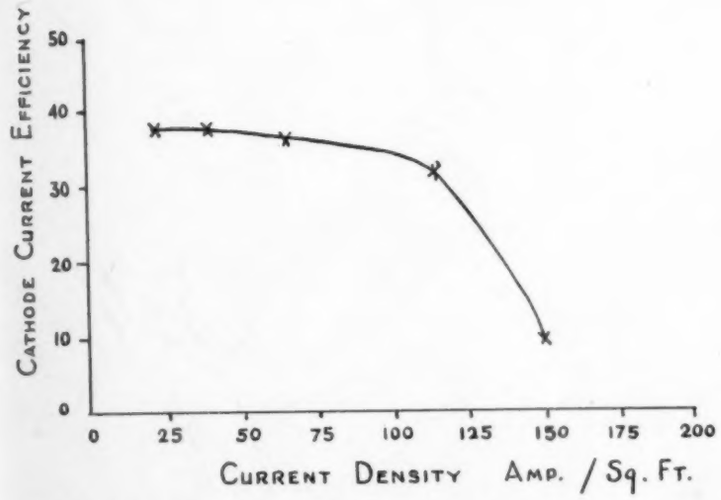


Fig. 2. Relationship between cathode current efficiency and current density.

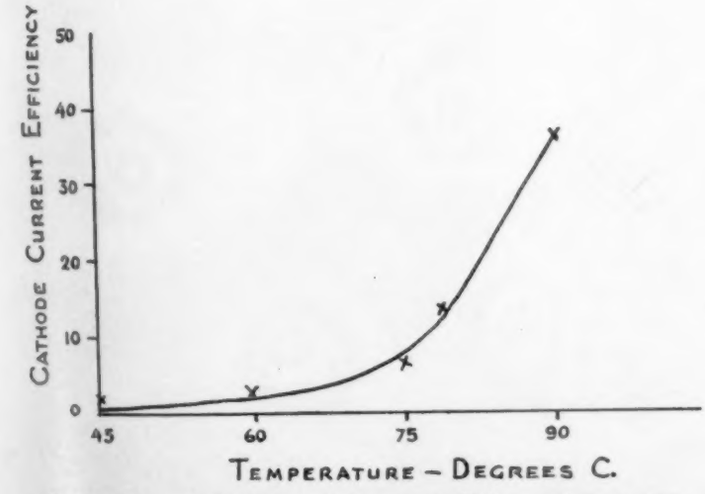


Fig. 3. Relationship between cathode current efficiency and temperature.

given below:

Platinic chloride	4 g./l.
or	
Platinum as chloride	1.5 "
Sodium phosphate (Secondary)	100.0 "
Ammonium phosphate (Secondary)	20.0 "

Conditions:

Volts	3-4
Current density	9.3 amp./ft.^{2}
Temperature	70-90° C.

This solution has to be boiled until the original orange color has turned into a pale yellow, indicating the formation of a complex ammino-phosphate. For bright flash deposits, a pH of 7 or slightly below is recommended. For heavier deposits an excess of ammonia is advisable.

The rate of deposition is rather low, about 8 milligrams per amp. minute in a new bath. The efficiency drops with use to about 4 mg. per amp. minute.

This solution is replenished by the addition of platinic chloride and of course has to be boiled after each addition keeping it ammoniacal all the time until the color is a pale yellow.

Due to the rapid accumulation of chloride, the useful life of this bath is very short.

The second type bath contains platinum as the diammino nitrite which contains 61% of platinum. The formula below is controlled by patents.[4, 5]

Ammonia nitrate	100 g./l.
Sodium nitrate	10 "
Platinum as diammino nitrite	10 "
Ammonia	50 cc./l.

Conditions:

Voltage	4.5
Current density	55-120 amp./ft.^{2}
Temperature	95° C.

It is stated that the throwing power of the bath is fair and covers very quickly. The bath can be replenished with platinum salts.

The criticism of most baths heretofore is that the deposits produced are dark colored and the life of the bath was limited.

4 and 5. U. S. Patent Nos. 1,779,457 and 1,779,436.

(*Concluded on page* 255)

Salt Spray Evaluation of Oiled Black Oxide Coatings on Steel[1]

By DR. A. KENNETH GRAHAM[2]

RECENT interest in black oxide coatings on steel for ordnance applications and as a substitute protective finish for strategic metal coatings on steel has lead to some misunderstandings with respect to the protective value that they afford. The salt spray has been universally used as a measure of the protection that can be obtained. Inability to check salt spray evaluations in different laboratories are not uncommon. Such differences may be due to variations in the salt spray apparatus and the manner in which it is operated. An experienced operator, however, employing salt spray equipment that is designed and operated substantially as described in the Army-Navy Aeronautical Specification AN-QQ-S-91, Dec. 12, 1938 (95°F with 20% sodium chloride brine by weight, 1.151 sp.gr. at 60°F) is likely to experience less difficulty in obtaining reasonably good confirmation of the findings of other laboratories. In the author's opinion some misunderstandings may be due to the nature of the protective coatings being tested and failure to adopt a standard procedure in conducting the salt spray evaluation designed to eliminate variations in the coatings.

Salt Spray Life Short for Unoiled Coatings

Black oxide coatings on steel, regardless of the chemical process by which they are produced, will fail in less than 10 hours in the salt spray test. This means that for other than a very mild indoor environment, supplemental protective films of lacquer or oils are universally employed. Excellent salt spray ratings are possible with combination oxide coating and supplemental film. In general, the protective value of the combination will be better than is possible with either the oxide or supplemental film coating when applied to steel individually.

In attempting to confirm these conclusions by salt spray tests, little difficulty is experienced where lacquers are employed as the supplemental film, because the manner of testing lacquer coatings in the salt spray offers no unusual complications. If, on the other hand, an oil film is employed for the supplemental protection, difficulty may arise owing to the fact that ordinary handling or wrapping of the oiled article may destroy or alter the uniformity of the oil film. Because of this a salt spray evaluation of such surfaces cannot be expected to give uniform results. Consequently, the writer's experience in testing oiled oxide coatings may be of value to those employed in similar activities.

Proper Application of Oil Important

The pieces to be tested should first be given the black oxide coating in accordance with the recommendations of the vendor of the particular process employed. They should then be given the supplemental oil film under the conditions recommended for the oil in question. After oiling they should be immediately placed in the rack to be used for supporting specimens in the salt spray cabinet in such a manner that the oil films on the significant surfaces and edges are not altered or destroyed by handling. It is advisable to allow the samples to drain or dry in this position for an overnight period, thus establishing equilibrium conditions in the oil film prior to testing in the salt spray.

In spite of precautions to insure uniform distribution of the brine mist within the salt spray chamber, local difficulties frequently exist. These may be sufficient to cause a variation in the hours required for a breakdown of the film. To eliminate the effect of this variation it is well to employ from 4 to 8 duplicate samples properly marked for identification and variously located throughout the salt spray chamber.

If panels are being tested the angle of the pieces makes a difference in the rating obtained. A set of oiled panels at a 60° incline in one case gave a rating for the upper side only of 4.0, i.e., the first appearance of rust, in 16% less time than was the case with a set in a vertical position, whereas the bottom side required 64% more time. In general, a vertical position gives more consistent evaluations, but when comparing different oils the angle of incline does not matter as long as it is the same for all samples. When testing irregularly shaped objects, however, it should be realized that the horizontal surfaces will fail first and the vertical surfaces last. Some misunderstandings undoubtedly arise because of the manner in which different operators interpret the results.

Evaluation of Results

As is the case in ordinary salt spray testing, frequent inspection periods are necessary when a short life is expected. Regardless of the time between inspections, the evaluation of the samples should be carefully standardized. It is suggested that the supporting racks be so designed that inspection can be accomplished without removing the pieces from the racks. It is best to remove the rack from the salt spray cabinet to a table where adequate light is available. The pieces should then be inspected without touching the protective oil film at any time.

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1. Contribution from the Alrose Chemical Company, Cranston, Rhode Island.
2. Consultant, A. Kenneth Graham & Associates, Jenkintown, Penna.

A convenient rating of the samples can be obtained by assigning numbers in accordance with the following schedule:

Rating Numbers	*Appearance of Surface*
5	Perfect, no rust.
4	First appearance of rust, 1 spot.
3	Slight rust, few spots.
2	Considerable rust.
1	Badly rusted.
0	Complete failure.

While the above procedure does not provide too definite a distinction between ratings of 2, 1 and 0, it should be noted that ratings of 4 and 3 are usually adequate to determine protective value and to make valid comparisons. If a number of duplicate test panels are employed, an average numerical rating will be determined at each inspection period. By plotting the ratings against the total hours for the various inspection periods, a curve is obtained from which the hours for a rating of 4 and 3 may be determined. Experience indicates that great differences between various protective oils will be observed by this procedure.

In those applications of black oxide coatings on steel where protective oil films are to be employed, it is frequently necessary to submit samples to Government and other laboratories for salt spray tests. It is suggested that the most sensible procedure to follow in such cases is to send the oxide coated pieces in the unoiled condition, taking the necessary precautions to wrap each piece separately in order to prevent mechanical injury of the oxide coating in transit. If a particular oil is to be employed in the evaluation of these pieces, it is suggested that a sample of the oil also be furnished with instructions as to how it should be applied.

It is frequently argued that if a salt spray rating of 50 hours is claimed for an oiled oxide coating on steel, it should be equivalent to any metallic coating giving a similar rating. There is a fallacy involved in this reasoning due to the fact that the metallic coating is not subject to injury by ordinary handling, whereas the supplemental oil film may be. In this connection it should be pointed out that where an oil film is specified over a black oxide coating it is frequently expected that the film will be replaced by regular oiling to adequately protect the surface. Consequently, the procedure recommended above for evaluating an oiled oxide coating in the salt spray is entirely consistent.

Salt spray ratings at best are not too exact. Therefore, too literal an interpretation of salt spray hours is not justified. It is in recognition of this fact that specimens treated with a "standard" oil film of known protective value are frequently employed as a blank with each series of tests in order to make reasonable comparisons with previous data.

Platinum Plating

(*Concluded from page* 253)

About 15 years ago one of the authors (J.F.D.) did an appreciable amount of work on platinum plating baths. A method was produced whereby a complex solution was obtained which when used under the desired conditions would give an attractive white non-tarnishing coating suitable for many uses. The plates produced are just a shade less white than rhodium deposits. Viewed at some angles the deposit is equal to or whiter than rhodium. This solution has been further developed and after endorsement by many prominent firms in the manufacturing jewelry field is now being placed on the market as an assayed platinum plating solution by A. Robinson & Son, 131 Canal Street, New York City. The solution is a concentrate containing 10 grams/liter of platinum as metal. The solution when diluted with distilled water and used under the proper conditions produces an attractive coating which is a good substitute for rhodium. This can be used directly on brass, bronze, white metal, steel, silver, sterling silver, etc.

The solution is used containing 2 to 10 grams/liter of platinum as a complex. The cathode efficiency varies widely depending upon the conditions imposed upon the solution. This is shown by the accompanying graphs. Figure I shows the relationship between cathode current efficiency and concentration of the platinum ions. The general trend, as one would expect is for greater efficiencies at higher concentrations of metal.

These data were obtained using 7.5 volts with a cathode current density of 144 amp./ft.^{2} The temperature of the bath was 87° C. while the time of the plate was 20 seconds. All plates were agitated.

In Figure II the variation of cathode current efficiency with current density is given. As one would expect the efficiency decreases when the current density is increased. These data were obtained using brass cathodes and a solution temperature of 90° C. The time of the deposit was 20 seconds and all plates were agitated. The concentration of platinum was 4 grams/liter.

In Figure III the variation of the current efficiency vs. temperature is shown. Here the efficiency increases sharply as the temperature is increased. The conditions imposed were as follows: voltage drop, 6.4; concentration of platinum, 4 grams/liter; agitation was used; cathode current density, 108 amp./ft.^{2}; time of plate, 20 seconds; cathode material, brass.

The throwing power of the bath is good. Attractive coatings are produced over curved surfaces. The ratio of anode to cathode area should be from 1:1 to 3:1. Stainless steel or platinum anode material can be used. The concentration of platinum can be from 2 to 4 grams/liter or higher, if desired. The voltage recommended is 7-9 volts while the pH should be 6.5 to 7.5. Evaporation of the solution is taken care of by the addition of distilled water. The metal can be depleted and then built back by adding the concentrated solution. In addition to the concentrate nothing more has to be done to the bath before continuing the plating. Simplicity of operation of the solution is one of its features. No other material has to be added at any time to maintain good operating conditions. Another feature, especially under present conditions, is the difference in the relative cost of the platinum and rhodium baths. The platinum bath is about half the cost of the rhodium.

Patents

Corrosion Prevention of Iron and Copper

U. S. Pat. 2,271,374-5. J. Mackay (Canada), assignor to Rust Proofing Co. of Canada, Ltd., Jan. 27, 1942. A process of coating articles of iron, copper and alloys of each of them which comprises subjecting to a fused mixture or alkali metal hydroxide, alkali metal phosphate and an oxidizing agent. Three baths are used, first the molten cleaning, stripping and coating bath, second, a neutralizing bath and third a sealing and/or coloring finishing bath. Crystalline copper sulfate or manganese dioxide in amounts of 0.5%-10% can be added to the formulas below, preferably in amounts of 1%-2% as fluxing and stabilizing agents. Operation is at 600°-900° F.

After coating in the fused bath, the articles are rinsed and neutralized in a weak solution of a suitable acid or aqueous solution of iron sulfate, preferably at a temperature of about 160° F. The preferred bath contains about 4 oz./gal. (Br.) of iron sulfate. The articles are then rinsed and may be darkened in a third bath containing a dye.

Examples:	1	2	3	4	5	6	7	8	9	10	11	12	
Trisodium phosphate	3	3	4	4	2	2	2	2	2	2	2	50	parts by wt.
Potassium nitrate	2	—	1	—	—	—	3	—	—	—	1	—	"
Sodium hydroxide	—	2	1	2	4	2	—	3	1	3	3	50	"
Sodium carbonate	—	—	—	1	—	—	—	—	—	1	—	—	"
Potassium phosphate	—	—	—	—	2	2	—	—	—	—	—	—	"
Sodium nitrate	—	—	—	—	—	2	—	—	3	—	—	—	"

Vitreous Enamelling

U. S. Pat. 2,271,706. W. C. Morris, assignor to Poor and Co., Feb. 3, 1942. An improvement in the bonding of vitreous enamels comprising immersion in a bath containing a hydrochloric acid solution of antimony trichloride, arsenic trichloride and stannous chloride.

Example:

First dissolve 0.6 lb. of antimony tetraoxide in a gallon of cold 18° Be. muriatic acid. Then add 0.0006 lb. of arsenic trioxide. Then add enough solution of stannous chloride in strong muriatic acid to turn the solution colorless or pale green.

After the usual acid pickle, the article is dipped in the above bonding solution, then rinsed in cold water for 1-5 minutes and neutralized in a solution containing ¼ to 1 oz./gal. of a mixture of 10%-90% borax plus 90%-10% soda ash at 140°-180° F. for 2 to 8 minutes.

Corrosion Prevention of Copper

U. S. Pat. 2,272,216. H. J. Lodeesen, assignor to Parker Rust Proof Co., Feb. 10, 1942. A process comprising subjecting the surface of copper or its alloys to a solution containing an acid phosphate selected from the group consisting of zinc, manganese, cadmium and magnesium and an oxidizing agent selected from the group consisting of persulfates, permanganates, iodates, nitrites and peroxides. This may be followed by a rinse in an acid solution from the group consisting of chromic, phosphoric and oxalic acids or in a solution containing a salt selected from the group consisting of iron, chromium and aluminum.

Example for brass:

Zinc dihydrogen phosphate	42 lb.
Ammonium persulfate	8 "
Water	100 gal.

5 minutes immersion at 200° F.

Example for brass:

Manganese acid phosphate solution	40 lb.
Zinc carbonate	1 "
Sodium nitrite	4 "
Water	100 gal.

15 min. at 210° F.

Example for brass:

Zinc dihydrogen phosphate	40 lb.
Sodium nitrite	4 "
Water	100 gal.

5 min. at 200° F.

Add nitrite continuously for better results as it decomposes rapidly.

Increasing the zinc content in the above solutions such as by adding zinc sulfate or nitrate improves the coating a great deal.

The final rinse may contain 7-21 oz./100 gal. of chromic acid, phosphoric acid, oxalic acid or salt of aluminum, chromium or iron and is operated at 150°-180° F.

Immersion Cadmium Bath

U. S. Pat. 2,272,777. G. Reuter (Germany), Feb. 10, 1942. A process for producing adherent coatings of cadmium on metals of the group consisting of copper, brass, iron, copper plated iron and brass plated iron without the application of an outside source of electric current by means of immersion in a hot solution of alkali cadmium salt containing an excess of free caustic alkali many times by weight that of the dissolved cadmium metal.

Example for Brass:

Cadmium oxide or salt	4	parts by wt.
Alkali cyanide	70-150	" " "
Water	1,000	" " "

Operate at 40°-70° C.

Example for Iron:

Cadium oxide or salt	5- 8	parts by wt.
Caustic alkali	1200-1400	" " "
Water	1,000	" " "

Operate at 125° C. Some alkali cyanide may be added to this bath.

Semibright Nickel Bath

U. S. Pat. 2,274,112. A. Wesley and J. W. Carey, assignors to The International Nickel Co., Inc., Feb. 24, 1942. A nickel bath consisting principally of about 260 to about 340 g./l. of nickel chloride and about 2 to about 35 g./l. of boric acid, with the pH adjusted to between about 0.7 and less than 3 by additions of hydrochloric acid, the bath being operated at about 80°-145° F. and 20-240 amp./sq. ft.

Example:

Nickel chloride	300 g./l. approx.
Boric acid	30 " "
pH	1.0
Temp. 110° F.	
C. D. 75 amps./sq. ft.	

Hot Dipping

U. S. Pat. 2,276,101. J. L. Schueler, Mar. 10, 1942. A process comprising subjection of metallic articles to be coated to a molten annealing and cleaning bath comprising borax, fluorspar and iron oxide, replenished with borax and fluorspar and keeping the iron oxide below 15%, removing said articles with a portion of said bath material covering the metal, allowing the temperature of the article to drop to the point where the salt solidifies but the temperature is still above that of the metal coating bath, mechanically removing said solidified materials from the articles for reuse and then coating said articles in the molten metallic coating bath.

Example of cleaning and annealing bath:

Borax	90%
Fluorspar	10%

Tin Plating

U. S. Pat. 2,274,963. E. W. Hopper, assignor by mesne assignments, to Crucible Steel Co. of America, Mar. 3, 1942. A method of producing smooth, bright, adherent coatings of tin and tin alloys on iron and steel strip which comprises electrodepositing a thin coating in the alkaline tin bath, followed by a heavy coating in an acid tin bath, and then immersing the coated strip in a hot bath of fatty acid containing non-oxidizing oil to fuse and brighten said coating and thereafter immersing said strip in a bath of cool non-oxidizing oil to harden said coating in said brightened condition.

Also as a new article of manufacture, a ferrous base metal having a duplex coating of tin or a high tin alloy produced by electroplating first in an alkaline tin bath and then in an acid tin bath.

Polishing Machine

U. S. Pat. 2,276,059. C. R. Moon, assignor to Ontario Mfg. Co., Mar. 10, 1942. A grinding and polishing machine for processing metal articles having a curved surface.

Abrasive Blasting

U. S. Pat. 2,279,342. N. J. Quinn, assignor to Quinnex Corp., Apr. 14, 1942. A centrifugal type of abrasive projecting apparatus of novel design.

Gold Drag-Out Recovery

U. S. Pat. 2,279,580. R. V. Miner, assignor to Western Electric Co., Inc., Apr. 14, 1942. An apparatus for flushing the drag-out film off gold plated articles and recovering the gold from this solution by circulating through containers filled with zinc and connected in series.

PLATING AND FINISHING
POLISHING — BUFFING
CLEANING — PICKLING
HOT DIP FINISHES

SHOP PROBLEMS

Sulphuric Acid Anodizing

Q. We would like to know why you have not published articles on sulphuric acid anodizing in METAL FINISHING, whereas you have published several articles on chromic acid anodizing. Has this failure to publish information on sulphuric acid anodizing been due to lack of interest or other reasons?

A. We have not felt at liberty to publish information on the sulphuric acid method of anodizing other than certain generalities, due to the fact that the process is patented and the patents are held by the Aluminum Company of America, Pittsburgh, Pa. Any inquiries regarding operation or installation of the bath should be addressed to the Aluminum Company of America, Pittsburgh, or to a local office of the company.

Information has been published on the chromic acid method of anodizing because the 5 and 10% baths are not covered by basic patents. It is interesting to note that revised Army-Navy Specification AN-QQ-A-696a, April 11, 1941, allows the use of either chromic acid or sulphuric acid methods, providing the alloy contains 5% of copper or less. If the alloy contains more than 5% copper, the chromic acid method cannot be used, and also if the parts are fabricated by methods other than welding. For parts containing joints or recesses that cannot be rinsed, such as in assembled parts, the sulphuric acid method cannot be used, and in these cases, the chromic acid method must be employed.

—W. R. M.

Silver Plating Upon Steel

Q. Due to the restrictions on plating of nickel, zinc and cadmium, we are required to silver plate our products made of steel. We would like to know whether we would be allowed to use a flash coating of copper or nickel upon the steel to act as a base for the silver, and if we are not allowed to do this, is it possible to silver plate satisfactorily directly upon steel?

A. If the project does not have a priority rating of A-1-k or better, then nickel cannot be used as an undercoat for the silver, and the plating of copper is at the present writing (April 22, 1942) still under the restrictions of M-9-c and unless you made the object of copper alloy previously, you are not allowed to use a copper flash.

It is possible to silver directly upon steel and obtain adherent deposits. Two so-called strike solutions are required preceding the regular silver plating solution. The first strike solution is very low in silver and high in free sodium cyanide, and a suggested formula is as follows:

Silver cyanide	0.13-0.25 Troy oz./gal.
Sodium cyanide ..	15 Av. oz./gal.

The second strike solution into which the work is placed directly from the first strike without rinsing, contains a higher silver concentration and a lower sodium cyanide concentration. A suggested formula is:

Silver cyanide	0.5-0.75 Troy oz./gal.
Sodium cyanide	10 Av. oz./gal.
Sodium carbonate ..	2 " "

If the silver content becomes too high, then metallic silver will plate out with little or no gassing, and if the silver content is too low, then burned deposits may result. Steel anodes may be used. Following the second strike solution, the work is transferred directly to the silver plating bath.

The length of time in each strike solution is that required to cover the piece with a film of silver.

Determining Hardness of Water

Q. To determine the proper amount of alkali to add to our burnishing barrels, we would like to estimate the hardness of the water used by us. Will you, therefore, give us a simple method for determining water hardness.

A. The hardness of water is obtained rather simply by a titration of a standard soap solution against a known quantity of the water. This soap solution may be standardized against a solution of known hardness, or it can be made by making a definite concentration of soap. A recommended method is as follows:

Place in a four ounce oil sample bottle 50 cc. of the water to be tested, marking the high water level on the bottle. This can be done with a glass cutter by simply cutting a line on the bottle at the 50 cc. point, or else attach a small strip of adhesive plaster or scotch tape. Use the small dropper bottle with standard soap solution. Add nine drops of the solution to the 50 cc. of water in the bottle and shake vigorously. If a one inch head of suds forms that remains stable for one minute the water may be considered as being zero hard or soft. If suds do not form then add standard soap solution in increments of 15 drops, shaking vigorously after each addition until a one inch stable suds forms for one minute. The total number of drops of standard soap solution added to the 50 cc. of water when divided by 30 will equal the hardness of the water expressed in grains per U. S. Gallon.

Formula for Standard Soap Solution

Put 28.5 cc. of normal potassium hydroxide solution in a flask and add a few drops of phenolphthalein indicator. Now in a separate container dissolve 10 grams of oleic acid or good grade of red oil in 75 cc. of neutral alcohol. Add this slowly with agitation to the potassium hydroxide solution until the pink color disappears, this indicating that all of the potash has been neutralized by the oleic acid. This mixture should then be diluted with alcohol to make 1000 cc.—H. Leroy Beaver.

Black Nickel Plating

Q. Will you please tell us the effects of excessive amounts of sodium thiocyanate in black nickel plating solutions.

A. In nearly all production black nickel plating, we have used Formula No. 1 as given in the 1941 Guidebook, which is as follows:

Single nickel sulfate	10 oz./gal.
Nickel ammonium sulfate	6 "
Zinc sulfate	5 "
Sodium thiocyanate	2 "

While other bath components were held quite closely to the concentrations indicated in the above formula, we have increased the sodium thiocyanate to as high as 3 oz./gal. with very good results. Operating characteristics and the deposits obtained with this higher thiocyanate concentration were apparently no different than with 2 oz./gal. of sodium thiocyanate.

In a different type of black nickel solution and on an experimental basis, we have varied the thiocyanate concentration from 1 to 10 oz./gal. with little apparent change in the deposits obtained.

In general, we have found that temperature and current density must be controlled very strictly and that bath composition is much less critical than might be supposed.

We hope the above is of some assistance to you, and wish that we had a great deal more information available on this point.

—John G. Poor.

Gold Alloy

U. S. Pat. 2,278,812. L. Weiss and J. Spanner (Germany), assignors to Handy and Harman, Apr. 7, 1942. A workable amethyst gold alloy capable of being sawed, bored and polished consisting substantially of 70.6 to 78.1% gold, 19.4 to 22.4% aluminum and 0.5 to 10.0% zinc, the gold and aluminum being present in such alloy in the proportion of substantially 78.5 parts of gold to 21.5 parts of aluminum.

American Electroplaters' Society's 30th Annual Convention

at Grand Rapids, June 8, 9, 10

THE American Electroplaters' 1942 Convention Committee, headed by *Chester W. Smith*, is to be commended on its work in preparing a convention which has so much to offer to those interested in metal finishing under present conditions. Although the convention is shortened to three days, all the important events are retained. The Educational Sessions will include the full number of papers. Production of material to bring the war to a speedy and successful conclusion is occupying a large percentage of American plants. Timely papers have been written with the object of fitting the metal finisher to best do his job with the armament program. Discussions of new developments in the protection of metals through plating, oxide coatings, and painting, and their use on army and navy equipment, occupy many of the papers.

No other city can offer as much as Grand Rapids in the realm of furniture. Convention delegates have in store for them a trip through the Imperial Furniture Co., largest manufacturer of tables in this country.

Grand Rapids is inaugurating the "First Annual Photographic Display" of the society at this convention. There will be hundreds of photos of all kinds including equipment (old and new), plated parts, people in activities and occupations, still life and animals. A feature of the display will be photos of former conventions including Bridgeport, Cleveland, New York, Milwaukee, Asbury Park, Dayton, and Boston.

Grand Rapids has everything for your pleasure and comfort, including unusually fine hotel accommodations, air conditioned theaters, libraries, magnificent Civic Auditorium, beautiful churches, museums, and art gallery.

Something different for the men will be a Victory Luncheon on the second day with the well known *A. P. Haake*, economist, as speaker and conductor of the "round table."

That the convention is not all on the serious side is evidenced by the entertainment planned to supplement the technical sessions. Social events include the International Fellowship Club Party and the regular Banquet with dinner, dancing, prize drawing, and floor show—the latter comprising outstanding talent of the middle west.

An extremely interesting program has been arranged by the Ladies' Committee. Luncheons at Herpolshiemer's Tea Room and at the Women's City Club are scheduled—of these, one is Aunt Ella's Party. Tours of the city's points of interest including lakes,

Hotel Morton

Hotel Pantlind—Convention Headquarters.

Hotel Rowe

gardens, museums, art gallery, and furniture show rooms, are sure to hold interest and will long be remembered. A special treat is planned for the last day with luncheon at Knollcrest Farm. Of course, the ladies attend the International Fellowship Party and the Banquet.

Convention Headquarters at Pantlind Hotel

This hotel has facilities to handle the entire convention and all meetings will be held there. The Pantlind, known as the "Entire City Block of Hospitality," has 750 rooms. There are four dining rooms, a bar, and twenty meeting rooms—all the larger ones air-conditioned. The Pantlind's trained personnel has had much experience in handling conventions.

The rates are as follows:

Single room, without bath, $2.20 to $2.75.
Single room, with bath, $2.75 to $5.50.
Double room, without bath, $3.85 to $4.40.
Double room, with bath, $4.40 to $7.15.

George Wagner
Supreme 2nd Vice President

Ellsworth T. Candee
Supreme President

Maurice R. Caldwell
Supreme 3rd Vice President

Charles C. Conley
Supreme 1st Vice President

Wm. J. R. Kennedy
Executive Secretary

The Rowe Hotel

The Rowe Hotel, only three blocks from Headquarters, has excellent facilities. Its garage, connected by tunnel to the hotel, offers free parking to its guests. The hotel contains a main dining room, coffee shop, and bar—the Hunt Room, and 300 sleeping rooms, all with tub and shower. The rates are as follows:

Singles, $2.75, $4.40.
Doubles, $4.25, $8.80.
Twin beds, $5.50, $8.80.
Suites, $9.75, $25.00.

General Program
Sunday, June 7th

3:00 P.M. Registration, Mezzanine Floor, Pantlind Hotel

Monday, June 8th

Monday Morning

8:00 A.M. Registration, Mezzanine Floor, Pantlind Hotel

9:00 A.M. Welcome to delegates by General Chairman, President of the Grand Rapids Branch and National President, *E. T. Candee*

10:00 A.M. Educational — Special Victory Session
Maurice R. Caldwell, presiding

Monday Afternoon

2:00 P.M. Educational — Technical Session on Plating
Clarence C. Helmle, presiding

Monday Evening

8:30 P.M. International Fellowship Club —Open House

Tuesday, June 9th

Tuesday Morning

8:45 A.M. Educational — Organic Finishing
Richard B. Saltonstall, presiding

Tuesday Afternoon

12:30 P.M. Victory Luncheon — Speaker, *Dr. Alfred P. Haake* — Round Table

3:00 P.M. Visitation of Imperial Furniture Factory

Tuesday Evening

8:00 P.M. Educational — Electroplating Session
Clyde Kelly, presiding

Wednesday, June 10th

Wednesday Morning

8:45 A.M. Educational Session — Oxide Coatings, Aircraft
Thomas F. Slattery, presiding

Wednesday Afternoon

2:00 P.M. Election of Officers, Reports, Selection of 1943 Convention

Wednesday Evening

7:00 P.M. Banquet and Dinner Dance—Floor Show

Educational Program

Monday, June 8th, 10:00 A.M.
Victory Session

1. "Military Applications of Electroplating," by *Wm. Blum*, U. S. Department of Commerce, National Bureau of Standards, Washington, D. C.
2. "Present Situation in the Electroplating Industry Regarding Government Restrictions and Government Business," by *Wm. McCord*, War Production Board, Washington, D. C.

Monday, June 8th, 2:00 P.M.
Technical Session on Plating

1. "Progress Report on the Effects of Polishing on the Protective Value of Plated Coatings," by *Gerald A. Lux*, A.E.S. Research Associate, National Bureau of Standards, Washington, D. C.
2. "Comparison of Effects of Copper Deposits upon Carburization," by *Merrill M. Thompson*, National Cash Register Co., Dayton, Ohio
3. "Preparation of Surfaces for Hard Chromium Plating," by *Arthur W. Logozzo*, Plastics Dept., General Electric Co., Pittsfield, Mass.
4. "Anode and Cathode Phenomena Shown in Color Photography," by *Frank K. Savage*, Research Chemical Engineer, C. G. Conn, Ltd., Elkhart, Ind.
5. "Passivity," by *Major F. A. Rohrman*, 6th Corps Area, Chicago, Ill.

Tuesday, June 9th, 8:45 A.M.
Organic Finishing

1. "Materials Application of Organic Finishing," by *F. H. Edwards*, DeVilbiss Co., Toledo, Ohio
2. "Formulation, Application, and Availability of Organic Finishes," by *C. A. Lankau*, Egyptian Lacquer Mfg. Co., New York
3. "Military Applications of Organic Coatings," by *Paul M. Goodell*, C. M. Hall Lamp Co., Detroit, Mich.
4. "Application of Phosphate Rustproofing in Defense Industries," by *V. M. Darsey*, Technical Director, Parker Rust-Proof Co., Detroit, Mich.
5. "Electrodepositing Paint Spray," by *Harold Ransburg*, Harper J. Ransburg Co., Indianapolis, Ind.

Tuesday, June 9th, 12:30 P.M.
Victory Luncheon

Speaker, *Dr. Alfred P. Haake*, Managing Director of the National Association of Furniture Manufacturers, Inc., Chicago, Ill., "We Must Win the War, but How?" Round Table Discussion of Economic and Business Trends.

Tuesday, June 9th, 8:00 P.M.
Electroplating Session

1. "Substitution of Iron for Nickel and Copper in Printing Plates," by *Vernon H. Lamb* and *Wm. Blum*, National Bureau of Standards, Washington, D. C.
2. "Indium Plating in Practice," by *Wm. S. Murray*, President, Indium Corp. of America, Utica, N. Y.
3. "Comparative Corrosion Tests of Ocean Water Spray vs. Standard Salt Spray," by *C. E. Heussner*, Eng. Div., Chrysler Corp., Detroit, Mich.
4. "Lead Sulfamate Plating Process," by *E. W. Schweikher*, Electroplating Div., E. I. duPont de Nemours & Co., Cleveland, Ohio
5. "Bright Copper Plating in Acid Baths," by *Frank Clifton* and *Wm. M. Phillips*, Electrochemical Dept., General Motors Corp., Detroit, Mich.

Wednesday, June 10th
Oxide Coatings—Aircraft Session

1. "Surface Treatments of Magnesium," by *H. K. DeLong* and *Wm. H. Gross*, Dow Metal Division, Dow Chemical Co., Midland, Mich.
2. "Preparation of Anodized Aluminum for Plating," by *W. J. Travers*, Krome-Alume, Inc., Buffalo, N. Y.
3. "Anodic Treatment of Aluminum by the Chromic Acid Process," by *L. J. Tubbs*, Chief Chemist, Mutual Chemical Co. of America, New York.
4. "Metal Finishing for Military Aircraft," by *E. R. Irwin* and *Lt. J. Teres*, Materials Division, War Dept., Air Corps, Wright Field, Dayton, Ohio.

Ladies' Program

Sunday—June 7th

3:00 P.M. Registration, Mezzanine Floor, Pantlind Hotel

Monday—June 8th

8:00 A.M. Registration
9:00 A.M. Opening of Convention, Welcome to Delegates by General Chairman, President of the Grand Rapids Branch, and President *E. T. Candee*
1:30 P.M. Luncheon and Games Party, Herpolsheimer Tea Room
8:30 P.M. International Fellowship Club —Open House. Dancing, Buffet Supper, Entertainment

Tuesday—June 9th

9:30 A.M. Tour of Furniture Factory Show Rooms, Imperial Furniture Co.—Robert W. Irwin Co.
1:00 P.M. Luncheon at Women's City Club, Aunt Ella Society Luncheon. Aunt Ella Society stands for the genial character who is in reality the Oakite Products Co. and Dave Clarin, her progenitor. It can readily be seen that A. E. S. are the initials for Aunt Ella Society, as well as, the American Electroplaters' Society. The program in the past two years for the ladies who attend the convention has been one of the high spots. The Oakite Products Co. have generously extended Aunt Ella to cover the Ladies' Luncheon on Tuesday at the Grand Rapids Convention. This will be held at the Women's City Club on the day of the visitations to the Furniture Factory Show Rooms. It will be a pleasant sojourn not to be forgotten, and Aunt Ella has seen to it that the ladies will be entertained as well.
2:30 P.M. Visitation of Grand Rapids Furniture Museum — Art Gallery
8:00 P.M. Convention Hosts to the Ladies. Entertainment, and Distribution of Convention Gifts

Wednesday—June 10th

10:00 A.M. Tour of City and Gardens
12:30 P.M. Luncheon at Knollcrest Farms
7:00 P.M. Banquet and Dinner Dance, Floor Show, Drawing of Prizes

The International Fellowship Club

Reports received from the Grand Rapids Branch indicate that the 1942 convention should be as successful as normal conventions held in the past.

The International Fellowship Club will continue to cooperate as in the past. The tentative program is as follows:

Annual Luncheon—Monday, June 8th
Swiss Room

Since we must give the hotel management definite information as to the number who will attend, and inasmuch as the Club will have a discussion on Open House and other matters presented at the annual meeting, it has been decided that this year the meeting will be exclusively for the manufacturers and representatives of equipment and supply houses catering to the plating and finishing industry. The order of business will be:

Lunch, election of officers and discussion of arrangements for Open House.

Open House—Monday Evening, June 8th

Grand Opening 8:30 o'clock. Dancing and refreshments. At 10:15 a buffet lunch will be served and will be available until closing.

As in the past, we trust that all those who register will attend Open House. The purpose of Open House, held on the first night of the convention, is to offer an opportunity for all registrants to become better acquainted and to create better cooperation in the industry.

This feature of the convention is provided by the liberal contributions of firms selling to the plating and finishing industry. These firms and their representatives invite you to attend. A program including a list of contributors will be distributed to registrants.

Ladies' Party

Since the convention period has been cut to three days, we have decided to omit this interesting feature.

Golf Tournament

This year the Club will not sponsor a tournament. We have, however, been given courtesy of several golf clubs and those who desire may play any time during the convention period. In closing I should like to take the opportunity on behalf of our contributors and their representatives to extend to all who attend a most cordial invitation to enjoy Fellowship features of the convention program.

THOMAS A. TRUMBOUR, Sec.

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Oil Dermatitis Preventive

Industrial dermatitis or skin disorders caused by bacterial or fungus infestations in cutting oils, drawing oils, core oils and similar compounds is claimed to be prevented by addition of odorless, water soluble germicide in tablet form. Tablets are dissolved at the rate of one tablet per gallon of emulsified oil base or compound. This solution is added to cutting oil base before dilution with water. Tablets are dissolved in alcohol before adding to paraffin base oil.

Product is also claimed to prevent odors and decomposition of oils by preventing or retarding bacterial or fungus growth. Tablets are packed 100 to box. Made by the Natriphene Company, 3337 Book Building, Detroit.

Centrifugal Galvanizer

The Leon J. Barrett Co., Worcester, Mass., have developed several types of centrifugal galvanizers, such as illustrated, to be used for either zinc or tin coating of metal.

The basket containing the work is placed in the machine after immersion in the molten zinc or tin, and is spun for from 3 to 5 seconds. The work is then immediately dumped into a cooling bath of water. The centrifugal machine is stated to produce smooth, bright work and to save considerable quantities of metal, which factor is particularly important at the moment. The excess metal thrown from the work is gathered around the machine and is returned to the kettle where it is melted and used over again without any loss.

Tin-lead mixtures can also be used for coating metals in addition to pure tin and zinc.

The centrifugals for galvanizing are available in capacities from 40 to 240 loads per hour, handling from 5 to 100 lb. loads. The machine is stated to have particularly fast pick-up and stop to assure fast work and to remove the excess molten metal before it has had an opportunity to solidify.

Centrifugal galvanizer.

Extinguisher for Magnesium Fire

Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y., have just developed "Magout Powder" which is said to easily and quickly extinguish magnesium fires. This powder, according to the manufacturer, instantly smothers fires caused by magnesium shavings in machine shops, or by magnesium incendiary bombs. It is a non-absorbent, finely pulverized dry powder, safe to handle and easy to use.

This powder is available either in bulk quantities or in handy, instant-action tubes for sprinkling on fire. This is a new type cardboard container, spiral shaped for convenience in handling with metallic ends and lined with paraffin. A quantity of Magout can be kept on reserve for it is said to be non-injurious and will not deteriorate.

Stop-Off Lacquer for Copper Plating Before Carburizing

The Michigan Chrome and Chemical Company, 6340 East Jefferson Avenue, Detroit, Michigan, has recently introduced a specially developed material called "Miccro Supreme Stop-Off Lacquer" which is stated to have proved effective in localized hardening of steel parts. By its use, the usual handling and grinding operations required before heat treating are eliminated.

In customary practice, steel parts which are to be hardened only in certain areas are copper plated completely. From the plating cycle, the parts are trucked to a grinder where the plating is removed from the portions to be hardened. The parts are then sent to the heat treating furnace.

In the simplified method offered by this new stop-off lacquer, a coating is applied on the areas to be hardened before they are plated. After plating, all that is necessary is to remove the lacquer and the pieces are ready for heat treatment without further preparation. The stop-off lacquer is easily applied and removed, and its use requires no special skill or equipment.

Automatic Sand Blasting Machine for Shells

Leiman Bros. Inc., 118-4 Christie St., Newark, N. J., have announced the development of a new sand blast machine for cleaning shells automatically.

This sand blast machine is equipped with a rotary table on which the work is held. The table extends into the interior of the sand blast machine itself, and while the outer edge of the table is being reloaded, the inside edge is under the blasting nozzles which are doing their work in the interior.

In practice, the table is operated by a motor which drives it at a prearranged and quickly changed rate of speed so that all of the shells or shell parts, which are being sand blasted, receive the full impact and cleaning effect of the sand or other material being used for cleaning purposes.

There are a number of nozzles which throw the sand in any direction which may be desired or concentrate it on one point. The actual sand blast operation is carried on, of course, inside the cabinet of the ma-

Professional Directory

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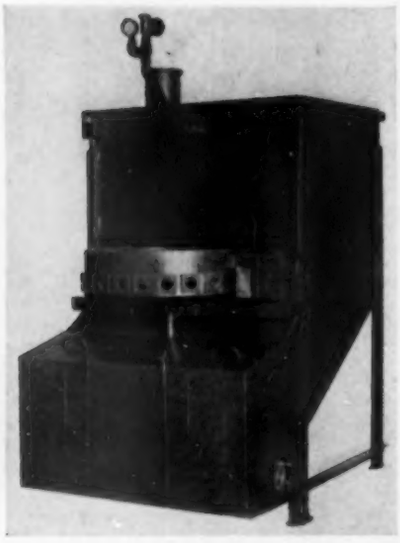

Sand blasting machine for cleaning shells.

chine so that no abrasive or dust can get outside or in any way affect the operator who works in the open.

A slotted, multiple rubber curtain prevents any blowing out of the abrasive or dust and at the same time a power suction blower, which may be in another location, is said to draw the dust from the interior of the machine itself, thus preventing any tendency of the dust to blow out.

The machine may be equipped with two or more nozzles, and they are set at the proper angle according to the work to be done. They concentrate over the surface of the work so as to sand blast every piece in every part, according to the manufacturer. The nozzles are of the suction type so that they draw the sand or the abrasive from the bottom of the machine where it is contained in a receptacle. After the sand is blown through the nozzle onto the work, it quickly drops to the bottom of this hopper to be used over again by the nozzle, which draws it up over the suction fan, sucking in the dust. Thus there is a continuous flow of sand or abrasive which is used over and over again.

The machine is stated to be adaptable for a wide variety of work in addition to the cleaning of shells. In fact, any sort of an article, whether it is made of steel, glass, Bakelite or any other material, can be handled just as well by this machine with very slight alteration, according to the company.

Rust Proofing of Machined Steel

By J. A. Stifter
The Milburn Co., Detroit, Mich.

The extreme importance of close tolerances in high-precision parts has ordained a re-examination of principles, techniques and products in commercial use for the prevention of rust. A high percentage of rejections in several vital defense industries has increased production cost, wasted materials, more hours of labor and delayed delivery of necessary parts and equipment.

Rust-proofing oils or solvents constitute the bulk of the conventional rust-preventive practice. Metals are either dipped or sprayed with one of these solutions which affords a fairly high degree of protection. Intensive study of the handling, machining and processing operations has at last disclosed the vulnerability of most accepted rust-proofing methods. Specifically, it was noted that many shops apply rust-proofing or rust-preventing materials prior to machining operations. During the machining operation it was discovered that additional surfaces of the metal were exposed. Immediately after the machining operation, the metal was again immersed in a rust-proofing bath which allegedly maintained the imperviousness of the metal to further oxidation.

The problem then resolved itself into a scientific answer to the question: Despite the precautions taken, how is it possible for metals to react to humidity or human perspiration and disclose rust spots in the final inspection?

A detailed analysis was made of each operation in the handling of highly finished metals. The individual steps were carefully checked with microscopic examination of the metals at fixed time intervals. Tests were repeated and results re-checked under a wide variety of working conditions.

TO AIRCRAFT
Contractors and Sub-Contractors:
For finishing—for trimming and burring—for removing sharp corners
OUR METHOD IS FAST AND INCREASES PRODUCTION.
Engine parts, guns, gears, etc., require the removal of burrs and the finishing of many parts. Don't use files and emery cloth. Use finishing Nuglu.
J. J. SIEFEN CO. DETROIT

At length it was discovered that the inexplicable rusting was caused by perspiration corrosion through contamination when the operator removed the job from his machine, after exposing new surfaces and *before the second rust-proofing immersion!* The fingerprints of the operator caused invisible focal points of oxidation which were sealed in by means of the second rust-proofing bath.

It was on the basis of this research that the "Dual-Protection" principle of rust-proofing was evolved. Stated simply, it consists of protecting the metal through application of rust-proofing materials *to the metal* with the additional precaution of applying rust-proofing material *to the hands of the operator*. Obviously, the conventional rust-proofing materials could not be used for *both* functions.

Experiments were conducted with various creams that could be applied to the hands of the operators, providing protection for both the operator and the metals upon which he worked. For the purpose of the experiment, bearing race rings of chrome alloy electric steel were used with the S.A.E. specification No. 52100.

Carbon	1.05%
Manganese	0.35%
Chrome	1.35%
Silicon	0.25%
Phosphorous	0.025% (not more)
Sulfur	0.025% (not more)

Hardened by quenching and then drawn. Rockwell hardness, average of 62.

The machine tooling operation utilized male operators and the metal was put through a 3% oil-in-water slush. Intervals of time between the operations varied from one to three days. The metals were cleansed of all grease and dirt after which they were examined both macroscopically and microscopically for any evidence of oxidation. Then the trial rust-preventing substance was smeared onto the metal, the excess wiped off, and the remainder rubbed into the metal until it disappeared. A control series was established and several variables were introduced, including humidity, temperature and artificial acid perspiration.

The results of the experiments established beyond all doubt that the use of a slush for the metals, plus the use of a cream for the hands of the operators represent optimum rust-proofing conditions. It was noted that changes in temperature, from 60° to 110°F. will not affect the efficiency of the rust-proofing products. Nor will changes in relative humidity, from 60% to 80% cause any decrease in efficiency of the product.

The material applied to the hands of the operator has the additional advantages of being non-toxic, easily applied and removed, as well as providing positive protection against industrial dermatitis.

Leacrest Party

The annual Leacrest Party, held at the home of *Bob Leather*, president of the *Lea Mfg. Co.*, Waterbury, Conn., will be held at "Leacrest," Bethlehem, Conn., Saturday afternoon, May 16th. All in the plating industry are welcome to attend. Tariff, $1.00.

Indium Finishes Your Plating Worries

The Studebaker Corporation recently announced that Indium-silver finish, developed under our patents, had been adopted for the exterior hardware and decorative trim of late run 1942 Studebaker cars.

Indium-silver plated finishes are recommended to replace such restricted metals as chromium, nickel, and rhodium. The Indium-silver finish supplies a stable surface, capable of high polish, and resistant to wear, corrosion, tarnish, and abrasion. This surface is actually an alloy and cannot chip or peel. It can be used for functional surfaces and decorative finishes.

Like silver, Indium is available in abundance, is domestic-mined and commercially priced. Our plating processes are fully developed, subject to royalty-free licenses, and readily adapted to standard plating equipment.

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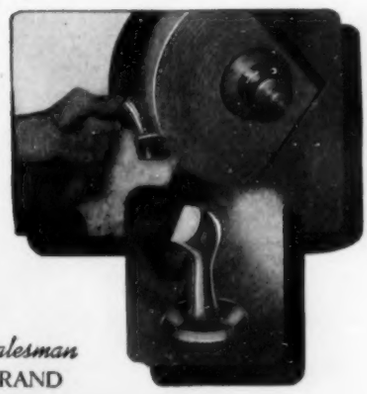

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DOING METAL CLEANING?
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BOOK YOU NEED!

IT'S YOURS FOR THE ASKING . . .

Whatever your metal cleaning operations are, you are sure to discover, in this new handbook, new ways and materials to increase metal cleaning efficiency in your plant. For example:

. . . The complete section on munitions cleaning, with many machine installation diagrams shows you how to speed up your operations on shells, bombs, etc.

. . . How to preclean for a physically clean surface by the Magnus Emulso-Dip and Emulso-Spray processes.

. . . How to effectively clean in electrocleaning tanks.

. . . How to handle final cleaning and anti-rusting in one procedure.

These are only a partial list of the wide range of metal cleaning and allied operations discussed in this new practical metal cleaning handbook. It will be of particular value to those plants working on products for war use.

Write for your copy today.

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Complete engineering service for industrial cleaning and all related processes. Method, design, construction and installation of equipment for washing, degreasing, pickling, burnishing and drying.

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Manufacturers' Literature

Blackening of Copper and Copper Alloys

The Enthone Co., New Haven, Conn., have just published a four-page folder describing a new process called, "Ebonol C", for simple, direct chemical blackening of copper and copper alloys, including bronzes, beryllium copper and low brasses. Adherent, hard, jet black coatings are stated to be produced in from 3 to 10 minutes. Operational details are given as well as cost data.

Carbon Brushes

Catalog K-15 of Keystone carbon, graphite, and metal-graphite brushes has just been issued by the *Keystone Carbon Co., Inc.*, 1935 State Street, Saint Marys, Pa. Types of Keystone metal-graphite brushes for low voltage generators and slip ring applications, and carbon-graphite brushes, for motors and generators, are illustrated. Also shown are fractional horsepower and automotive brushes, as well as metal-graphite and carbon contacts, negative temperature coefficient resistors, and Selflube porous bronze and porous iron bearings.

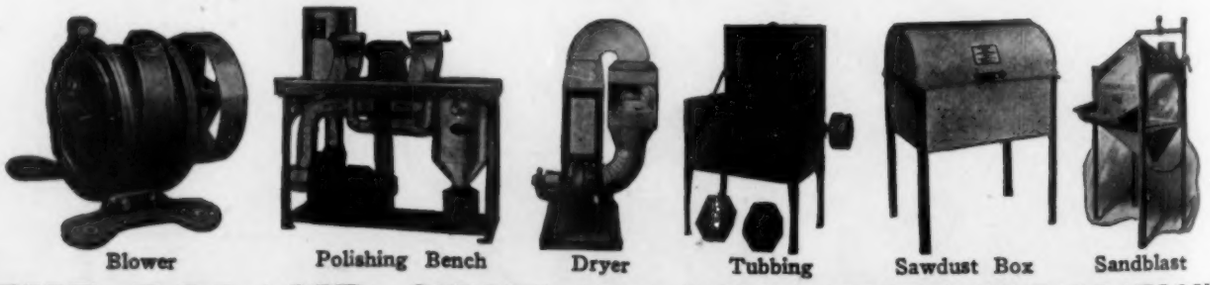
The new catalog contains base prices of standard sizes of brushes and gives a simple method for computing prices for each style. Copies of Catalog K-15 are available free upon request.

Controlled Heat Treating Atmospheres

Lithium Corp., Raymond-Commerce Bldg., Newark, N. J., have recently issued an 8-page booklet describing the company's special process for obtaining chemically neutral heat treating atmospheres by the use of lithium. Chemical reactions involved in the process are given and flow sheets and charts are used to illustrate the text.

Hand Guard for Grinders

Industrial Gloves Co., Danville, Ill., have developed a new hand guard for protection of the worker's hands during grinding.



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The guard is stated to be sturdy, comfortable and long-wearing. It is made of chrome tanned cowhide reinforced on the back, which is subjected to wear, with an extra patch of leather steel reinforced.

Metal Cleaning Compounds

Fidelity Chemical Products Corp., 430 Riverside Ave., Newark, N. J., have recently published a 30-page booklet, describing the company's various cleaning materials. These materials include special cleaners for metals, such as aluminum, brass, copper and steel. Other cleaners and products described are for hand cleaning, maintenance, rag washing, pre-cleaning, stripping and spray cleaning. Various valuable tables of weights and measures are included. Appended, are upkeep charts for recording the charging and control of cleaning tanks.

Metal Cleaning

Magnus Chemical Co., Inc., have just issued a new illustrated handbook entitled "Metal Cleaning in War Time." This handbook discusses in detail the metal cleaning problems in the production of shells, shell cases, fuses, other munitions and other parts and objects involved in the production of material and equipment vitally important to the war program.

In addition to the specific cleaning problems of munitions, this handbook also covers the outstanding cleaning operations required in the production of ordnance, small arms, material, transport equipment and other metal items which must be built to meet the complex and extensive demands of the war.

The book places emphasis on the company's new processes of emulsion cleaning to remove both organic matter and solid dirt. The handbook is complete with many flow charts, illustrations and diagrams of washing machines used in the manufacture of munitions and other vital metal objects. Several pages are devoted to cleaning in maintenance and repair shops and the important subject of the cleaning and protection of employees' hands and skin.

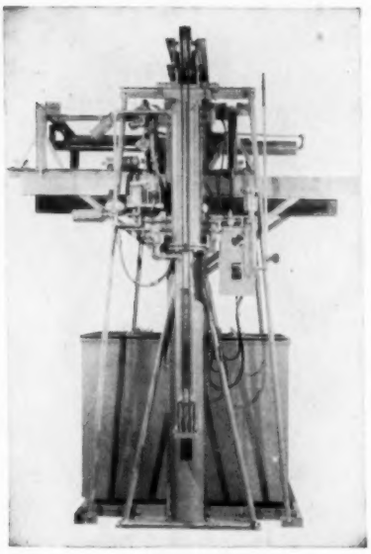
Copy of this book can be obtained by writing to Magnus Chemical Corp., Inc., Garwood, N. J.

New Books

Work Routing, Scheduling and Dispatching in Production. By John Younger, and Joseph Geschelin. Revised Edition. Published by The Ronald Press Co., New York. Size 6" x 8½"; 158 pages. Price $3.25.

This is a revised edition of the book entitled, "Work Routing in Production". The book has been written for two groups of readers—executives and others concerned with daily problems in industry, and students of industrial management and engineering in college classrooms.

Crown Pick-up Unit



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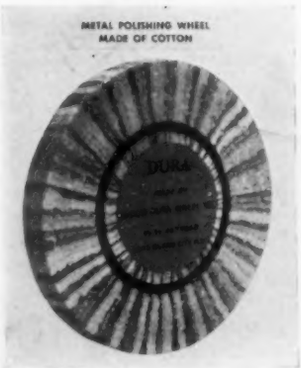

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The following chapter headings indicate the scope of the text: Work routing; blueprints; the instruction form; material; analysis of operations; importance of the machine; economic considerations; lot sizes; interrelation of work routing, standardization and cost accounting; cost accounting for planning; job shop planning; the Gantt chart in work routing; centralized vs. decentralized planning; company policies; quality control; simultation; tools, jigs and fixtures; planning from the sales curve; material handling; production personnel; planning the new building; planning for accelerating or freezing production; rhythm in manufacturing, and sundry problems.

Diffusion In and Through Solids. By R. M. Barrer. Published by Macmillan Co., New York, and University Press, Cambridge, Eng. Size 5½" x 8½"; 452 pages. Price $6.50.

This book should find ready acceptance because of the great importance of diffusion phenomena in industry. For example, diffusion is involved in case hardening of metals, hot tinning, hot galvanizing, formation of bearing alloys for aircraft work, and in various processes relating to heat treatment. The diffusion of gas is also important, particularly in electroplating, and the phenomenon of hydrogen embrittlement is well known.

In the first chapter of the book, the author discusses various solutions of the diffusion equation, starting in with the differential forms of Fick's laws. The second chapter deals with stationary and non-stationary states of molecular flow in capillary systems. The third chapter, dealing with gas flow in and through crystals and glasses, discusses structures of silicates and glasses, and diffusion of water and ammonia in zeolites.

The subject of gas flow through metals is treated in chapter 4. The study includes solubility of gases in metals and alloys, the influence of various physical factors on permeability, and the influence of various other factors such as grain boundary, phase changes and pre-treatment on permeability.

Chapter 5 is devoted to diffusion of gases and non-metals in metals. A measurement of diffusion constants in metals is considered, and the important subject of degassing of metals and absorption of gases in finely divided metals is treated.

In another chapter, attention is devoted to diffusion of ions in ionic crystals and the interdiffusion of metals. Diffusion of gases in organic solids is also treated.

This book should be of value to chemists, physicists, metallurgists and engineers.

The Physical Examination of Metals. By Bruce Chalmers and A. G. Quarrell. Volume II, Electrical Methods. Published by Longmans, Green & Co., New York. Size 5¾" x 8¾"; 274 pages. Price $6.00.

This book contains information, which, to the writer's knowledge, is not summarized in any other text, but of course, is available in the various periodicals.

Magnetic properties of materials and measurement of these properties are given considerable treatment. Another chapter is devoted to electrical measurements, such as

resistance. In this chapter, thermoelectrical effects are treated, and the practical importance of this section is the construction and principles of temperature measurement by use of thermocouples. Other apparatus, such as for measuring thickness by the so-called "thermoflux" method is described.

Chapters are devoted to theory and principle of x-ray diffraction as applied to examination of metals, such as for determining crystal size and orientation, and considerable treatment is devoted to the newer type measurements using electrons.

One of the authors, A. G. Quarrell, is particularly familiar with apparatus using the electron beam. The Finch electron diffraction camera is described, as well as recent applications of electron diffraction. Other electron equipments discussed are the high resolution electron microscope, electron scan microscope, cathode microscope, simple electron microscopes and field emission microscopes. The concluding chapter is devoted to radiography.

The book is written in a relatively nontechnical manner and should be of particular interest to physical metallurgists and physicists.

Obituary

Glen Cannon

Glen Cannon died on April 15, in Chicago, Ill. He was born in Kouts, Ind., on October 19, 1883.

Mr. Cannon started with the Matchless Metal Polish Co., Chicago, Ill., in February 1912 as a bookkeeper, and a few years later went out as a salesman. A short time after that, he was appointed as assistant division manager of the Chicago plant, after which he was elected treasurer. In 1920, he was elected secretary and held both offices until his death, having in the meantime been advanced to division manager. In 1930, he reorganized Advance Polishing

Glenn Cannon

IN THE process of manufacturing these many, many engines of war, there are countless parts that must be cleaned after machining, grinding, lapping, plating, heat treating, etc., to insure proper performance.

• For cleaning pistons, crankshafts, camshafts . . . projectiles, cartridge cases, bombs . . . bomb fins and fin assemblies . . . for every conceivable metal-cleaning purpose, and for use in all types of equipment, there is a specialized Wyandotte Degreasing Compound.

• And Wyandotte Field Engineers are always ready to assist with your cleaning problems.

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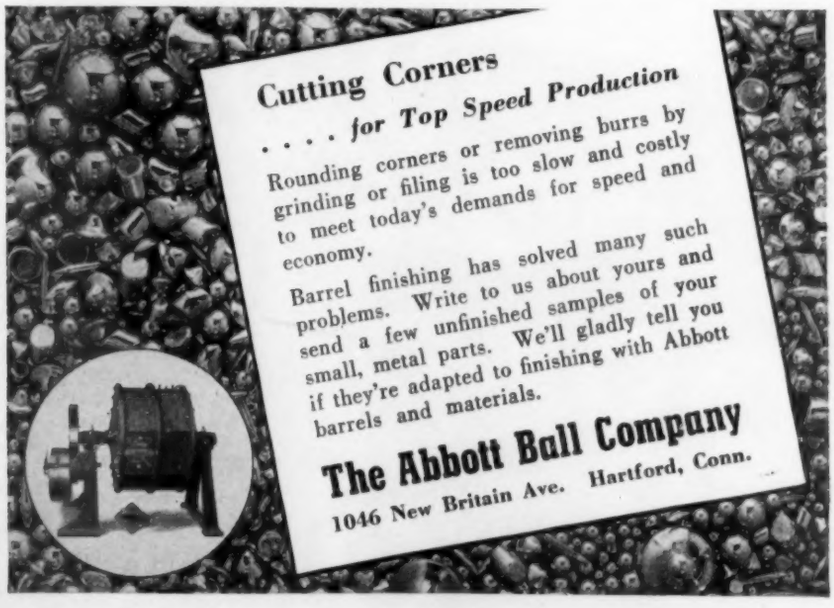
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. . . . for Top Speed Production
Rounding corners or removing burrs by grinding or filing is too slow and costly to meet today's demands for speed and economy.
Barrel finishing has solved many such problems. Write to us about yours and send a few unfinished samples of your small, metal parts. We'll gladly tell you if they're adapted to finishing with Abbott barrels and materials.
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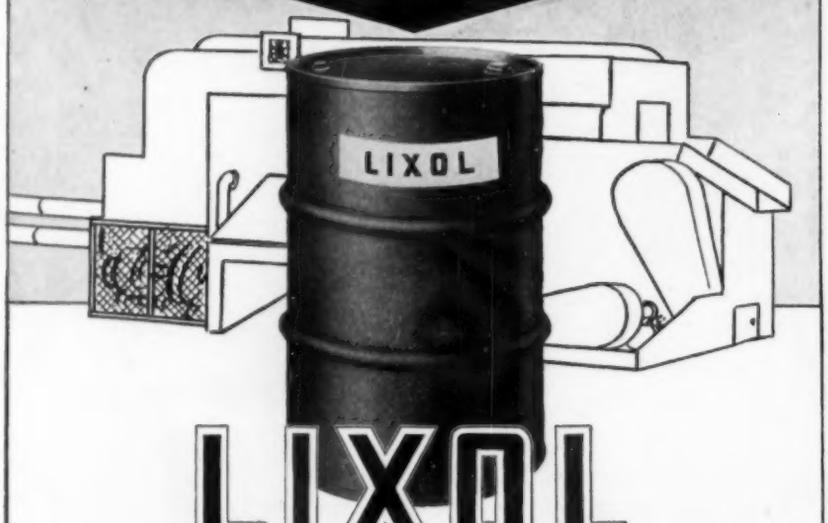
THE *SPEED* SOLUBILIZER



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★ Removes oil, grease, smut, grime, and impacted abrasives. Use with water or kerosene. Protects against rust and tarnish. Excellent for production of physically clean surfaces without attack on production metals. Safe, versatile, efficient.

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MEETS TODAY'S DEMANDS
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CINCINNATI OHIO

Wheels, Inc., a subsidiary of the Matchless Metal Polish Co., and since that time had been secretary, treasurer and general manager of the Advance company, for which he was responsible for the construction of a new plant.

Mr. Cannon was active in the Buff and Polishing Wheels Mfrs. Association, in which association, he was highly regarded. He leaves his widow, Mrs. Florence Cannon of Chicago, two sons, Harold of Terre Haute, Ind., and Russell of Akron, Ohio, and two grandchildren.

Personals

A. H. Clem, for the past three years district sales-service representative of the Penn Salt Cleaner Division in the Detroit area, has been transferred to the executive offices of the *Pennsylvania Salt Manufacturing Company* in Philadelphia. He will coordinate the activities of the company's Industrial Cleaner Division, recently enlarged to handle the increasing metal cleaning problems of war goods manufacturers. Mr. Clem graduated from Pennsylvania State College with the degree of Bachelor of Science in Chemical Engineering. He went to the Detroit territory after a year in the Company's Research Department.

Dean E. McCrory attached to the Pittsburgh office of the heavy chemical sales division of the *Pennsylvania Salt Manufacturing Company* since 1936, has been transferred to the company's executive offices in Philadelphia. He will be concerned with the sales of a number of important products of the company.

Mr. McCrory graduated from Franklin and Marshall College and took graduate work in sanitary engineering at Carnegie Tech. In Pittsburgh, he lived at 419 College Avenue, Oakmont.

Clarence E. Clark Elected President of Whittaker, Clark & Daniels, Inc.

At the annual election of officers of *Whittaker, Clark & Daniels, Inc.*, on March 25th, *Clarence E. Clark*, formerly Vice President, was elected President to succeed his father, Samuel H. Clark, who died November 13, 1941. Other officers elected were: *Harold C. Robinson*, Vice President; *W. Wallace Roff*, Vice President; *John A. Franklin*, Secretary and Treasurer; *John A. Seidler*, Assistant Secretary and *L. E. Clark*, Assistant Treasurer.

Whittaker, Clark & Daniels, Inc., have been importers, manufacturers and exporters of minerals, colors and pigments for over fifty years and have risen to a prominent place in the industry.

At the Golden Anniversary Dinner of the organization in January 1941, *Samuel H. Clark* celebrated forty-three years as President.

Arthur H. Losey Joins Hammond Machinery Builders

Arthur H. Losey is a recent addition to the staff of the Automatic Polishing and Buffing Division of *Hammond Machinery Builders, Inc.*, Kalamazoo, Michigan.

Mr. Losey for the past 6 years was associated with the J. C. Miller Co., Grand Rapids as engineer and advisor on all polishing and buffing problems.

Having started as an apprentice in his father's job plating shop in Kansas City, Mo., Mr. Losey went to Michigan in 1928 to weld this early training into a chain of wide practical experiences. Starting to work with Michigan Bumpers, then called Wolverine Bumpers, he has been associated since with such well known manufacturers as Alloy Spring and Steel, Jackson; General Spring and Bumper, Chicago; Winters and Crampton, Grand Rapids; W. B. Jarvis Co., Grand Rapids; National Brass, Grand Rapids; J. C. Miller Co., Grand Rapids.

Business Items

Recruiting Continues for Technologists

About a year ago the Federal Civil Service Commission began a recruiting drive for technologists. The number of persons on the employment lists now established is not sufficient for today's wartime needs. Accordingly, the Commission has recently reissued the announcement of these opportunities for Government employment with slightly modified requirements. Salaries for the positions range from $2,000 to $5,600 a year. Applications may be filed until further notice with the Commission's Washington office.

Sylphon Control saves HEAT, SPOILAGE, LABOR

for Standard Plating Works

At the Standard Plating Works, San Francisco, California, Sylphon Control not only maintains bright nickel plating temperatures at the desired degree for most effective results—i.e., best plating at lowest steam consumption—but labor and supervision are reduced to the point where "the control is set by the workman who walks away and practically forgets it" until time for removal of plated products.

The company reports: "The dependability and trouble-free operation of these Controls, that respond quickly and hold correct temperatures within close limits, effect a saving in heat, materials and manufacturing costs."

Write for Bulletin JA-20.

FULTON Sylphon FOR TEMPERATURE CONTROL

THE FULTON SYLPHON CO.
KNOXVILLE, TENNESSEE
Representatives in All Principal Cities in U.S.A. and in Montreal, Canada and London, England

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"The One Bath Process"

Our Government has indicated its approval of *Black-Magic* in its acceptance of this process as a final finish for Small Arms, Machine Gun Parts, Quartermaster Depot items of equipment, Buttons, Buckles, Sight Parts, Tank Parts, Airplane Parts, Navy and Marine items.

WE GUARANTEE,

the same, or deeper penetration, the same, or better rust proofing and better color, than any two bath processes and will prove it in your own tanks, or no pay.

Black-Magic processes for Iron, Copper, and Zinc Die Castings.
Witch-Dip, a special wax base rust proofing dip.

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By technologists the Commission means a person experienced in "the necessary production, engineering, and scientific research work essential for the successful operation of an industrial plant, where such plant operation is based upon a thorough and expert knowledge of a branch of an applied science", such as explosives, fuels, plastics, rubber, minerals, or textiles.

For the Junior positions ($2,000 a year), applicants will no longer have to take a written test, and, as before, no written test will be given for the higher positions. The maximum age limit for all the grades has been raised to 60 years.

Copies of the announcement (No. 188), and the forms for applying, may be obtained at first- and second-class post offices, or from the Civil Service Commission, Washington, D. C.

Canadian Permag Products Ltd., is now located in their 5 story plant with greater manufacturing facilities—45% more space for larger stocks of their industrial cleaning compounds. Their general offices are at 131 St. Peter Street, Montreal, Can.

Penn Salt Plans $1,750,000 Plant

The Pennsylvania Salt Manufacturing Company, announced it has arranged a contract with the Government for the construction and operation of a new plant in the Philadelphia area for the manufacture of materials used in war goods production.

Financing for the plant, which will cost $1,750,000, will be provided by the Defense Plant Corporation. Construction will begin immediately and the plant is expected to be in operation within six months. Design and construction contracts have been awarded the firm of Day and Zimmerman, Philadelphia.

"We cannot announce the exact character of the new plant's production," said Leonard T. Beale, President of Penn Salt, "but it will fill a vital need in many fields of war goods production. The new plant will greatly increase our participation in the war effort. At present, 55 percent of our entire output goes into the manufacture of war goods."

The Udylite Corp., announces the new location of its Eastern District offices and warehouse. A complete line of electroplating and polishing supplies will be maintained for the convenience of customers. The new address is 11-16 Forty-Fourth Drive, Long Island City, N. Y.

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Quaker Chemical Products Corp., Conshohocken, Pa., have announced that *Allan d'Apery Mills* has recently joined the company's laboratories in the capacity of organic research chemist, and he is now working on machining compounds. Mr. Mills was formerly associated with Rohm & Haas Company, Philadelphia.

J. Perzanowski has also been added to the staff of the company as an organic chemist. He was formerly connected with the laboratories of the United Gas Improvement Company, and is now working on special assignments.

Miss Ruth Smock, a graduate of Temple University, has been employed to work in the company's control laboratory.

The Milburn Co. have announced the removal of their offices and plant to 3246 E. Woodbridge Ave., Detroit, Mich. This move was made to provide for enlarged capacity, to increase manufacturing facilities. The company specializes in the manufacture of rust-proofing materials and products for protection of workers' skin in industry.

Tillman Electro Plating Works, Inc., have announced that the company's name effective March 30, 1942, was changed to *American Electro Plating Works, Inc.* The company will continue to do business at the address, 636 - 11th Ave., New York City.

Strange as it may seem, silver is now becoming its own substitute. In the manufacture of flatware, the use of Sterling silver is on the increase but silver plated flatware, and hollow ware as well, are on the decline because of the scarcity of copper and nickel.

The new cent, or penny, for 1942 will consist of 95% copper and 5% zinc. Heretofore it had 95% copper, 1% tin and 4% zinc.

In ordinary gold beating, the leaves of foil are finally about 1/200,000 of an inch thick. An ounce of gold is thus extended to the surface of about 100 sq. ft. A still greater degree of thinness has been obtained but not profitably. A thinness has been obtained so that a grain of gold would cover 52 sq. in.

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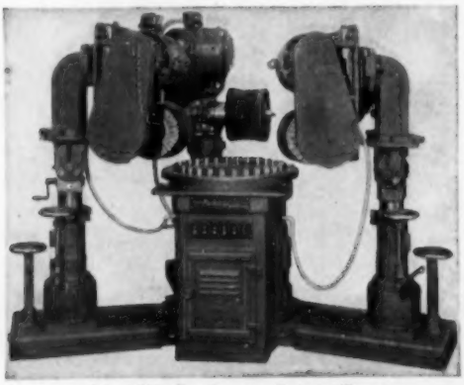

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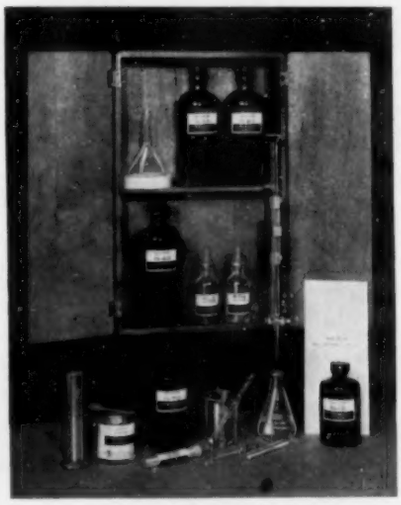

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